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ADVERTISEMENT.

The extension of the scope of the National Museum during the past few years and the activity of the collectors employed in its interest have caused a great increase in the amount of material in its possession. Many of the objects gathered are of a novel and important character, and serve to throw a new light upon the study of nature and of man.

The importance to science of prompt publication of descriptions of this material led to the establishment, in 1878, of the present series of publications, entitled "Proceedings of the United States National Museum," the distinguishing peculiarity of which is that the articles are published in pamphlet form as fast as completed and in advance of the bound volume. The present volume constitutes the seventeenth of the series.

The articles in this series consist: First, of papers prepared by the scientific corps of the National Museum; secondly, of papers by others, founded upon the collections in the National Museum; and, finally, of facts and memoranda from the correspondence of the Smithsonian Institution.

The Bulletin of the National Museum, the publication of which was commenced in 1875, consists of elaborate papers based upon the collections of the Museum, reports of expeditions, etc., while the Proceedings facilitate the prompt publication of freshly-acquired facts relating to biology, anthropology and geology, descriptions of restricted groups of animals and plants, the discussion of particular questions relative to the synonymy of species, and the diaries of minor expeditions.

Other papers of more general popular interest are printed in the Appendix to the Annual Report.

Papers intended for publication in the Proceedings and Bulletin of the National Museum are referred to the Advisory Committee on Publications, composed as follows: Frederick W. True (chairman), R. Edward Earll (editor), Tarleton H. Bean, Otis T. Mason, Leonhard Stejneger, and Lester F. Ward.

S. P. LANGLEY,
Secretary of the Smithsonian Institution.

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OF THE

UNITED STATES NATIONAL MUSEUM.

VOLUME XVII. 1894.

NOTES ON MAMMALS OF BALTISTAN AND THE VALE OF KASHMIR, PRESENTED TO THE NATIONAL MUSEUM BY DR. W. L. ABBOTT.

By FREDERICK W. TRUE,
Curator of the Department of Mammals.

Dr. W. L. ABBOTT has very generously presented to the Museum the skins and skulls of a number of species of Kashmir mammals, the majority of which were unrepresented in the collection.

Among them are three species of Voles (*Arvicola*), which appear to be undescribed, and also a new geographical race of *Mus arianus*. The specimens of the Rhesus monkey also seem to me to be worthy of a separate subspecific name. The discovery of the recently-described *Sminthus concolor* in Kashmir extends the range of that species a thousand miles.

The collection was made between 1891 and 1893.

SEMNOPITHECUS SCHISTACEUS, Hodgson.

Dr. Abbott obtained two specimens of this fine monkey at Kaj Nag. He states that in both specimens the face, ears, palms, and soles were black, and the callosities dusky. The iris is clear brown. He gives the following dimensions:

Measurements and weight.	21842, ♂, jr., Kaj Nag.	21843, ♀, Kaj Nag.
	Inches.	*Inches.*
Length of head and body in straight line	25	23.5
Length of tail vertebræ	26.5	26
Girth	22	24
	Pounds.	*Pounds.*
Weight	30	32

21842. Male, young. Kaj Nag, April 16, 1892. 8,000 feet.
21843. Female. Kaj Nag, April 16, 1892. 8,000 feet.

MACACUS RHESUS VILLOSUS, new subspecies.

Dr. Abbott obtained in Lolab the skins of five monkeys, which appear to represent a variety of the common *M. rhesus*. I at first supposed them to represent *M. assamensis*, but after a careful comparison with Anderson's description of the type of that species I became convinced that they were not the same. They present the following characters: Fur long and dense, and moderately wavy; ears hairy; hair of the crown directed backward, not radiating; upper surfaces, from the crown to the rump, nearly uniform rusty-brown, but brightest and purest posteriorly. Outside of fore limbs dull gray, overlaid proximally by the brown color of the shoulders. Thighs rust-colored; hind feet pale, sooty; chin, neck, breast and inside of fore limbs gray, with a slight yellowish admixture; belly and inside of the hind limbs yellow-brown, paler than the back. Face dusky; cheeks grayish yellow-brown. At the postero-external base of the ears is a tuft of rather long gray hairs, with reduced rust-colored tips; ears clothed with grayish hairs, but with a blackish fringe about the upper margin. Callosities pale in color and closely surrounded by fur. Tail thick, dark gray above. Iris pale brown.

Dr. Abbott gives the following measurements of the fresh specimens:

Measurements and weight.	20123, ♂, Lolab, Sept. 8, 1891.	20120, ♂, Lolab, Sept. 8, 1891.	20124, ♂, Lolab, Sept. 9, 1891.	20121, ♂, jr., Lolab, Sept. 9, 1891.	20122, ♂, jr., Lolab, Sept. 9, 1891.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Length of head and body	$23\frac{1}{2}$	22	23	19	14
Length of tail, with hairs	$9\frac{1}{2}$	11	11	$10\frac{1}{2}$	$7\frac{1}{2}$
Length from between shoulders to end of longest finger	$23\frac{1}{2}$	$22\frac{1}{2}$	22	$18\frac{1}{2}$	$13\frac{1}{2}$
Length from middle of rump to end of middle toe	$24\frac{1}{2}$	23	23	$19\frac{1}{4}$	14
Girth of chest	$19\frac{3}{4}$	$20\frac{1}{2}$	$19\frac{1}{2}$	$15\frac{1}{2}$	$11\frac{1}{4}$
Girth of belly	$23\frac{1}{2}$	$22\frac{1}{2}$	24	$18\frac{1}{2}$	$12\frac{1}{2}$
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Weight	34	31	24	15	6

It will be observed from the foregoing table that the length of the hind limb, measured from the middle of the rump, is almost exactly equal to the length of the head and body. The fore limb is only slightly

shorter. The average length of the tail in the four adult specimens is slightly less than half that of the head and body, or about 48 per cent.

The skull of one of the males is of the following dimensions:

Measurements.	35488, ♂, Lolab, Kashmir.
	mm.
Total length from anterior margin of premaxillæ to occipital crest	136
Basilar length from anterior margin of foramen magnum to anterior margin of premaxillæ	97
Length of palate	54
Length of upper molar series	35
Zygomatic breadth	97.5
Height of orbit	23.5
Breadth of orbit	30
Length of anterior nares	22
Breadth of anterior nares	14
Depth of mandible at coronoid process, vertically	55

All the specimens were taken in the pine forests at Lolab, in the Vale of Kashmir, in September, 1891, at an elevation of 7,500 feet.

$\frac{20120}{35485}$. Male. Lolab, Kashmir, September 8, 1891. TYPE.
$\frac{20121}{35486}$. Male, young. Lolab, Kashmir, September 9, 1891.
$\frac{20122}{35487}$. Male, young. Lolab, Kashmir, September 9, 1891.
$\frac{20123}{35488}$. Male. Lolab, Kashmir, September 8, 1891.
$\frac{20124}{35489}$. Male. Lolab, Kashmir, September 9, 1891.

FELIS TORQUATA, F. Cuvier.

Dr. Abbott assigns to this species, with hesitancy, a skull (No. 36396) which he obtained in the Lolab Valley, Kashmir. He remarks: "This cat was shot in a jungle close to a village and was thought to be a tame specimen. I am not now sure that it was not a wild one. The tame cats in Kashmir resemble the wild ones almost exactly. This one's skin (not preserved) agreed with the description of *F. torquata*."

CANIS AUREUS, Linnæus.

A single skull (No. 36395) from the Vale of Kashmir has been labeled by Dr. Abbott as belonging to this species.

VULPES MONTANUS, (Pearson).

There are two specimens of this handsome fox in the collection, one from the Shigar Valley, Baltistan, and a second from the Vale of Kashmir. They agree well with the description given by Mr. Blanford,* except that the ears are white within, and there is no black spot in front of the eye. The fur is very thick and long in the winter specimen.

* Blanford, Fauna of British India, Mammalia, 1888, p. 153.

Dr. Abbott gives the following dimensions (and the weight) of the specimen taken in May:

Measurements and weight.	21693 ♂, Vale of Kashmir.
	Inches.
Length of head and body (straight)	27.75
Length of tail, with hairs	20.50
Height at the shoulder	16.50
	Pounds.
Weight	13

20410. Male. Shigar Valley, Baltistan, January 10, 1892. 8,000 feet.
$\frac{21693}{36394}$. Male. Vale of Kashmir, May 20, 1893.

PUTORIUS CANIGULA, (Hodgson).

A normal specimen of this weasel, which is in the collection, confirms Mr. Blanford's conjecture regarding the occurrence of the species in Kashmir. It is from Sonamarg in that State.

20400. Male. Sonamarg, Kashmir, March 31, 1892. 8,600 feet.

URSUS THIBETANUS, F. Cuvier.*

Dr. Abbott gives dimensions of three Himalayan black bears which he obtained, as follows:

Measurements and weight.	20119, ♀, Lolab.	21844, ♂, Lolab.	21845, ♂, jr. Lolab.
	Inches.	*Inches.*	*Inches.*
Length of head and body	60	62	53
Length of tail, with hairs	4	5	4
Length of fore leg from top of scapula	35		
Chest girth	34	37	39
		Pounds.	*Pounds.*
Weight		175	160

$\frac{20119}{35484}$ Female. Lolab, Vale of Kashmir, June 23, 1891.
21844. Male. Lolab, Vale of Kashmir, June 25, 1891.
21845. Male, young. Lolab, Vale of Kashmir, June 26, 1891.

URSUS ISABELLINUS, Horsfield.

I am unable to follow Blanford in uniting this species with *Ursus arctos*. It appears to me to present differences in the shape of the skull, and also in the length of the intervals between the teeth and in the shape of the last upper molar. This tooth is very long and has the posterior moiety directed obliquely outward.

* *Ursus torquatus*, Wagner.

Dr. Abbott obtained skins of two Isabelline bears. Both bears were taken in spring, were very thin, and had two cubs with them. He gives the following dimensions (and the weight):

Measurements and weight.	21691, ♀, Nag Marg. *a*	21692, ♀, Krishna-gunga range. *b*
	Inches.	*Inches.*
Length of head and body in straight line		50.05
Length of head and body along the curves	61	
Length of tail vertebræ	4	4.5
Length of tail, with hairs		6.5
Girth of chest	42	37
Girth of belly	45	
Height at shoulder		29
	Pounds.	*Pounds.*
Weight	175	130–140

a The measurements of this specimen are from the skinned carcass. The following from the unskinned animal are too small, as it was in *rigor mortis* when measured and could not be properly stretched out:

Total length along curves	59.0 inches.
Length of tail with hair	4.5 inches.
Girth of chest	49.0 inches.
Height at shoulder	28.5 inches.
Height at rump	27.5 inches.

b Dr. Abbott remarks that the bear could not be well stretched out and that the length is too short and the height (29 inches) too great.

$\frac{21691}{36392}$. Female. Nag Marg, Kashmir. May 16, 1893.
$\frac{21692}{36693}$. Male. Krishnagunga range, Kashmir, April 26, 1893.
26397. Male, jr. Krishnagunga Valley, Kashmir, April 26, 1893 (skull).

OVIS VIGNEI, Blyth.

The skins of three male sheep were obtained. So far as regards the horns, they agree perfectly with the descriptions of *O. vignei.* In coloration, however, they seem to approach *O. cycloceros.* The general color is rufous brown, the short beard is made up of very dark brown and white hairs mingled, the legs below the knees and hocks are entirely white (though more or less stained from the soil), and the muzzle is also white. There is a distinct dark lateral line in the adults, terminating anteriorly in one case in a rather broad blotch. It will be seen that in many of these particulars the coloration of these skins differs from the original description by Blyth,* who, however, as Dr. Sclater has remarked, apparently had *Ovis cycloceros* also in mind. Blyth's description was taken from a painting (by Vigne). He states among other things that the muzzle is not white and that the limbs are brown. In repeating this description, however, in the Annals and Magazine of Natural History† he adds a footnote, in which he gives the characters of some specimens from the Hindu Kush Mountains, "identified by Mr. Vigne as, without doubt, the same as *O. vignei.*" In this description he emphasizes the fact that the muzzle is white, and states in addition that the limbs are covered with short white hair and that the belly is also white.

* Proc. Zool. Soc., London, 1840, p. 70.

† Vol. 7, 1841, pp. 251–253.

The description contained in this footnote is much more fully applicable to Dr. Abbott's specimens than the original one, and it seems probable that Vigne's sketch, on which the latter was founded, was either incorrect in many particulars,* or represented a young male in summer pelage.

Dr. Abbott gives the following dimensions of fresh specimens:

Measurements.	20407, ♂.	20408, ♂.	21847 ♂.
	Inches.	*Inches.*	*Inches.*
Length of head and body[a]	56	53	57
Length of tail to end of hairs	6.5	6	6
Girth of chest	42.5	35	38
Girth of belly	43	....	45
Depth of chest in straight line	16	....	15.5

a Note by Dr. Abbott: "These animals were shot in very difficult ground, so that measurements are only approximate, particularly the length and height."

The specimens obtained are as follows:

20407. Male. Shigar Valley, Baltistan, January 1892. 10,000 feet.
20408. Male, young. Shigar Valley, Baltistan, January 1892. 10,000 feet.
21847. Male. Shigar, Baltistan. 9,000 feet.

CAPRA SIBIRICA, Meyer.

Two skins of males from Baltistan represent this species. They are in winter pelage and very dark. The colors of the two skins are almost identical, and the markings are very sharply defined, in which latter feature they appear (as well as may be learned from the descriptions of various authors) to differ from ordinary specimens of *C. sibirica.* The following is a description of one of these skins, No. 20409: Face, neck, breast, fore legs, shoulders, the lower part of the flanks, the thighs, a line along the spine and the tail, strong umber-brown. The hind legs are also brown, but have a sharply-defined, large, oblong, white (or cream-colored) mark on the postero-external part of the metatarsus, extending from the hock to the outer false hoof, and prolonged between the latter and the true hoof.

A white mane (tinged with brown at the extremities of the hairs) extends along the spine from the middle of the nape to the shoulder. The brown of the shoulders follows, and behind this the whole back is occupied by a large elliptical white mark, or saddle (somewhat washed with brown), which is bisected longitudinally by a dark-brown spinal line, as already stated. Belly whitish. Ears white at the base anteriorly, brown elsewhere. The beard is blackish brown, with a few soiled-white hairs at its base. A narrow white area surrounds the anal region. All the hairs are white or whitish at the base—purest where the extremities are merely tinged with brown, and less so where they are dark.

*The same remark applies to the figure published by Dr. Sclater in 1860. (Proc. Zool. Soc., London, 1860, pl. 79.) It does not agree with the diagnosis which it accompanies.

This description tallies in all essential points with that for male specimens in winter pelage from the Sajan Mountains identified with *Capra sibirica* by Radde,* but scarcely with Blanford's diagnosis of the species in the Fauna of British India, where it is remarked (p. 504), "In winter the general color is yellowish white, tinged with brown, or greyish." Not less unsatisfactory is the phrase in Sterndale's diagnosis, "dirty yellowish white in winter"† Under the heading of varieties of *Capra sibirica*, however, Blanford remarks: ‡

A very dark-colored ibex is said to occur in Baltistan, but is, according to Scully, merely the old male in winter vesture. Ibex from Siberia and from the Thian Shan Mountains north of Káshgar have the abdomen and the back of the carpus and tarsus white, contrasting sharply with the front of the legs, which is very dark brown. Col. Biddulph, to whom I am indebted for calling my attention to this character, is of opinion that the Thian Shan animal is true *C. sibirica* and the Himalayan one distinct, in which case the latter would take the name of *C. sakin*. I have only been able to examine one undoubted Himalayan skin, and cannot say if the difference is constant.

Dr. Abbott gives the following dimensions of the fresh specimens:

Measurements and weight.	20409 ♂. Braldu Valley.	21846 ♂. Braldu Valley.
	Inches.	*Inches.*
Length of head and body	67	65
Tail to end of hairs	11	10.5
Height at shoulder (curved)	39	39
Height at rump (curved)	42	42
Girth of chest	48	48
Girth of belly	58	..
Depth of chest in a straight line	20	20 *a*
	Pounds.	*Pounds.*
Weight (about)	250	250

a The horns of No. 21846 measure 34½ inches around the curve.

20409. Male. Braldu Valley, Baltistan, December 19, 1891. 14,000 feet.
21846. Male. Braldu Valley, Baltistan, December 21, 1891. 21,000 feet.

PTEROMYS ALBIVENTER, Gray.

There are three normal specimens of this flying-squirrel in the collection, and also two specimens of the melanistic variety.

$\frac{20126}{35491}$. Male. Central Kashmir, September 15, 1891.
$\frac{20128}{35493}$. Male. Lashkok Nullah, September 16, 1891.
20135. Female. Western Kashmir, July 3, 1891.
20134. Male, young. Western Kashmir, July 3, 1891 (melanistic).
$\frac{20130}{35495}$. Female. Central Kashmir, September 17, 1891 (melanistic).

SCIUROPTERUS FIMBRIATUS, Gray.

Of this species there are four specimens, as follows:

$\frac{20125}{35490}$. Male. Central Kashmir, September 15, 1891.
$\frac{20127}{35492}$. Male. Lashkok Nullah, September 16, 1891.
$\frac{20129}{35494}$. Female. Lashkok Nullah, September 16, 1891.
$\frac{20131}{35496}$. Male. Central Kashmir, September 20, 1891.

* RADDE, Reisen im Süden von Ost-Siberien, 1, 1862, p. 244.
† STERNDALE, Mammalia of India, 1884, p. 444. ‡ *Op. cit.*, p. 504.

ARCTOMYS CAUDATUS, Jacquemont.

Two specimens of this fine marmot were collected, as follows:

$\frac{20136}{35499}$ Female. Vigh Nullah, August 1, 1891.
$\frac{20137}{35500}$ Male. Vigh Nullah, August 1, 1891.

MUS ARIANUS GRISEUS, new subspecies.

Similar to typical *Mus arianus*, Blanford, in size and proportions, but having the upper surfaces ochraceous gray, instead of rufous.

The Long-tailed Field-mouse has already been recorded by Dr. Scully as occurring in Gilgit. There are three skins in Dr. Abbott's collection which are referable to this species, but appear to represent a distinct color-variation. Mr. Blanford describes *M. arianus* as being "rufous brown above," and Mr. Thomas as "dark red."* Dr. Abbott's specimens are grayish, ochraceous brown above, which color is produced by the mingling of hairs having ocher-colored tips, with others which are black. No. 20151, which is immature, is especially gray above, and coincides in color almost exactly with ordinary specimens of *Mus musculus*.

The three specimens on which this subspecies is founded were obtained by Dr. Abbott in pine forests at high elevations—two of them in Central Kashmir and the third in the Pir Panjal Pass. He gives the following dimensions of the fresh specimens:

Measurements.	20151, ♂. Central Kashmir.	20139, ♀. Central Kashmir.	20144, ♂. Pir Panjal Pass.
	Inches.	*Inches.*	*Inches.*
Length of head and body	$3\frac{3}{8}$	4	$3\frac{7}{8}$
Length of tail	$3\frac{6}{8}$	$4\frac{4}{8}$	$4\frac{3}{8}$

As Mr. Blanford and Mr. Thomas have remarked, *Mus arianus* is very closely related to the *Mus sylvaticus* of Europe, if not identical with it specifically. Mr. Thomas has brought forward the greater length of the hind foot as a distinguishing character of *M. sylvaticus*. Dr. Abbott's specimens, being dry skins, are not entirely available for critical comparisons of this kind. The length of the hind feet in two of them, measured after soaking the feet in water, are as follows: No. 20144, male, 0.833 in.; No. 20139, female, 0.875 in.

The larger of these two dimensions is still a little less than an average of measurements of *M. sylvaticus* given by Mr. Thomas, which is 0.88 in.

I may here remark incidentally that a specimen of *M. sylvaticus*, from Switzerland (No. 2995), in the National Museum, is of exactly the same color as is shown in the figure of the type of *M. arianus* in Mr. Blanford's Zoology of Persia.* If this figure is correctly colored, it seems

*Proc. Zool. Soc. London, 1881, 548.

to me that *M. arianus* may scarcely be called "dark red." None of the specimens of *M. sylvaticus*, in the National Museum, from different parts of Europe, show a strong rufous tint, except one from England.

The types of *M. arianus griseus* are as follows:

$\frac{20151}{35514}$. Male. Mountains of Central Kashmir, September 13, 1891. 10,000 feet.
$\frac{20139}{35502}$. Female. Central Kashmir, October 8, 1891. 8,500 feet.
$\frac{20144}{35507}$. Male. Pir Panjal Pass, August 31, 1891. 8,500 feet.

MUS BACTRIANUS, Blyth.

There are five small mice in Dr. Abbott's collection which so closely resemble the common house-mouse, *Mus musculus*, that I have had some doubts as to whether they should not be referred to that species. As the tail, however, is shorter in every instance than the head and body, and the belly is white, or only slightly tinged with buff, I presume they really represent *Mus bactrianus*. Two specimens are from Srinagar and the remaining three from other localities in Kashmir. Dr. Abbott remarks that the species lives in the houses of the Gujar herdsmen.

The following dimensions are from the fresh specimens:

Measurements.	20150, ♂. Central Kashmir.	20397, ♀. Srinagar, Kashmir.	20142, ♀. Vale of Kashmir.	20143, ♀. Vale of Kashmir.	20149, ♂. Srinagar.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Length of head and body ..	$3\frac{1}{8}$	$3\frac{6}{8}$	3	3	$2\frac{6}{8}$
Length of tail...............	$3\frac{3}{8}$	$3\frac{1}{8}$	$2\frac{7}{8}$	$2\frac{5}{8}$	$2\frac{2}{3}$

The localities, etc., are as follows:

20397. Female. Srinagar, Kashmir, April 5, 1892.
$\frac{20150}{35513}$. Male. Central Kashmir, October 17, 1891. 9,000 feet.
$\frac{20142}{35505}$. Female. Vale of Kashmir, August 10, 1891.
$\frac{20143}{35506}$. Female. Vale of Kashmir, August 11, 1891
$\frac{20149}{35512}$. Male. Srinagar, August 8, 1891.

MUS RATTUS, Linnæus

Four specimens, as follows:

21688. Vale of Kashmir, June 5, 1893. 5,200 feet.
21689. Male. Vale of Kashmir, June 6, 1893.
20395. Young. Vale of Kashmir, winter, 1891–'92.
20399. Male. Srinager, Kashmir, April 4, 1892.

SMINTHUS CONCOLOR, Büchner.

It is a matter of surprise to find specimens of this recently, described species in the collection. The types, the only known specimens, so far as I am aware, came from Kansu, China, a thousand miles eastward. Dr. Abbott's discovery of the species in Kashmir adds greatly to its known range. His two specimens agree perfectly with the original

*Persian Boundary Commission, II, Zoology and Geology, 1876, pl. v, fig. 3.

description of the species. They are both from Central Kashmir, and were obtained at an elevation of 11,000 feet. Dr. Abbott gives the following measurements of one specimen, No. 20140: Length of head and body, $2\frac{3}{4}$ inches; length of tail, $4\frac{1}{4}$ inches.

$\frac{20140}{35503}$. Male. Central Kashmir, July 21, 1891.
$\frac{20141}{35504}$. Male. Central Kashmir, July 24, 1891.

ARVICOLA FERTILIS, new species.

Size medium. Length of head about one-fourth that of the head and body together. Tail-vertebræ one fourth to one-sixth the length of the head and body together. Ears moderate (as long as the fore feet, without the claws), overtopping the fur by about 4 millimeters.

Color above, dull grayish brown; below, pale isabelline brown. All the hairs plumbeous at the base. Those of the under surfaces are uniformly tipped with pale brown (white, tinged with burnt sienna). The hairs of the back have a subterminal ring of the same pale brown color, and blackish tips; numerous umber-brown hairs are intermingled. Ears, nose, and backs of feet umber-brown. Tail bicolored, umber-brown above and very pale sienna-brown below, corresponding with the coloration of the body. The long hairs at its extremity are chiefly from the under side and therefore light-colored. A nearly pure-white spot on the under side of the wrist in most specimens.

Dentition that of the subgenus *Alticola*, Blanford. Anterior upper molar with three outer and three inner angles. Posterior molar with two outer and two inner angles and a terminal oval lobe. (In one specimen there is an additional rudimentary angle on each side behind the other two.) Anterior lower molar with three outer and four inner angles, and an anterior oblique oval lobe, which may develope a rudimentary angle on each side.

Dimensions of the body.

Measurements	$\frac{20146}{35509}$, ♀, Central Kashmir.	$\frac{20147}{35510}$, ♀, Pir Panjal Mountains.	$\frac{20148}{35511}$, ♂, Pir Panjal Mountains.	59293, ♂, Kaj Nag Mountains.	21690, ♂, Krishnagunga Valley.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Head and body *	4.50	4.50	3.375	4.25	4.125
Tail vertebræ	.80	1.05	†.87	.70	1.125
Tail, with terminal pencil*	1.00	1.25	....	1.00	....
Ear from the orifice	.35	.40	.35	.33	.58
Hind foot, without claw	.61	.61	.57	.62	....

* These measurements were made on the fresh specimens by Dr. Abbott; the rest are from the dry skins.
† Dr. Abbott gives 1.625 inches for the tail and hairs, but I think this must be an error, and have substituted a measurement of the vertebræ from the dry skin.

Dimensions of the skull.

Measurements.	35509, ♀.	35510, ♀.	35511, ♂.
	mm.	*mm.*	*mm.*
Total length	....	25.5	23.5
Zygomatic breadth	15	16	14.5
Length of nasals	7	7.5	7
Length of superior molar crowns	5.5	6	6

Localities.—Central Kashmir, the Pir Panjal range, and the Kaj Nag Mountains.

This species appears to closely resemble *Arvicola wynnei*, Blanford, and may, perhaps, be only a geographical race of the same. It has, however, considerable longer ears and shorter tail. It also differs in color, being yellowish-brown, rather than "dark rich brown," or "dark chestnut," which are the colors given by Mr. Blanford for *A. wynnei*. The type of the latter species is from Murree (Marri), which is in Rawul Pindee, about one hundred miles west of the Pir Panjal pass and across the Jhelum River.

Dr. Abbott remarks that the surface of the ground in many of the alpine valleys of the Pir Panjal range is completely honeycombed by the burrows of this species. The elevations at which the species were obtained are indicated in the following list of specimens:

$\frac{20146}{35509}$. Female. Central Kashmir, August 2, 1891. 12,000 feet.
$\frac{20147}{35510}$. Female. Pir Panjal range, August 30, 1891. 8,500 feet. TYPE.
$\frac{20148}{35511}$. Male. Pir Panjal range, August 30, 1891. 8,500 feet.
59293. Male. Kaj Nag Mountains, April 23, 1891. 8,000 feet.
21690. Male. Krishnagunga Valley, May 10, 1893. 7,000 feet.

ARVICOLA MONTOSA, new species.

Size of the single specimen, small. Tail vertebræ about one-third the length of the head and body together. Ears as long as the fore foot from the wrist (without the claws), but not overtopping the quite long fur. Soles with six tubercles; the hindermost in the middle of the sole. Behind this point the sole is hairy.

Color above, dull grayish brown, as in *A. fertilis*, but considerably paler than in that species. Under surfaces white, very lightly tinged with brown, and the gray of the base of the hairs plainly seen. Feet white. Tail bicolored, corresponding with the coloration of the body. The long hairs at the extremity are mostly from the upper side of the tail and therefore dark. Ears clothed within with short yellowish-brown hairs. The anterior outer margin, except at the tip, with long hairs like those of the body. A tuft of long, nearly pure-white hairs behind the ears. Nose dusky brown. Claws pale, overhung with long white hairs.

Dentition that of the subgenus *Alticola*, and similar to that of *A. blanfordi*, but with four external angles on the posterior upper molar. Internal angles of the same tooth, three in number. Anterior lower

molar with four external and four internal angles. The first external angle as long as the others—not shorter, as in *A. blanfordi*. In the posterior lower molar the middle external and internal angles alternate, and the space between them is, therefore, not lozenge-shaped.

Dimensions of the body.

Measurements.	20145/35508, ♂, Central Kashmir.
	Inches.
Head and body *	3.625
Tail-vertebræ	1.15
Tail, with terminal pencil *	1.25
Ear from the orifice	.45
Hind foot, without claw	.71

* These measurements were made on the fresh specimen by Dr. Abbott.

Dimensions of the skull.

Measurements.	35508/20145, ♂, Central Kashmir.
	mm.
Total length	24
Zygomatic breadth	14
Length of nasals	7
Length of superior molar crowns	6

Locality.—Central Kashmir, 11,000 feet.

This species resembles *Arvicola roylei*, but differs in the form of the teeth. The color is paler than in *A. roylei*, and the ears are longer, though not overtopping the fur.

Dr. Abbott notes that the single specimen obtained was caught in a tent on October 4, snow being on the ground at the time.

20145/35508. Male. Central Kashmir, October 4, 1891. TYPE.

ARVICOLA ALBICAUDA, new species.

Similar to *A. blanfordi* in size and color, but with a shorter, entirely white tail. Dentition like that of *A. roylei.*

Ears visible in the fur. Thumb with a rudimentary claw. Tail two-fifths the length of the head and body, densely clothed with rather long hairs. Posterior portion of soles densely hairy. Fur on the back, 15 mm. long.

Color above, pale reddish gray, the hairs dark plumbeous at the base, with a subterminal ring of pale yellow, and brown tips. The peculiar pale tint of the back is produced by the mingling of these three colors. Ears clothed with long hairs; those of the margin pale orange-brown. Upper lip and all under surfaces pure white; the hairs gray in the lower half. Fore and hind feet and tail pure white, the hairs white to the base.

Dimensions of the body.

Measurements.	No. 20393, ♀ Braldu Valley, Baltistan.	
	Inches.	*mm.*
Head and body	4.25	107
Tail	1.75	44.5
Ear, from base of orifice, from the dry skin	.56	14
Hind foot, without claw, from the dry skin	.64	16

The teeth closely resemble those of *A. roylei*, and have the same number of angles throughout, but the anterior loop of the first upper molar is transverse, and the first inner angle of the anterior lower molar is not longer or more curved than the succeeding ones.

Dimensions of the skull.

Measurements.	$\frac{36816}{20393}$ ♀ Braldu Valley.
	mm.
Basilar length, from outer margin of foramen magnum to end of premaxillæ	25
Zygomatic breadth	15

$\frac{20393}{36816}$. Female. Braldu Valley, Baltistan, December 19, 1891. TYPE.

LEPUS TIBETANUS, Waterhouse.

Dr. Abbott gives measurements of six fresh specimens of this hare, four of which are in the collection. All of them were obtained in the Shigar Valley, Baltistan, January 9 and 10, 1892.

Measurements and lists of specimens.

Cat. number.	Locality.	Sex.	Length of head and body.	Length of tail.	Weight.
			Inches.	*Inches.*	*Pounds.*
20403	Shigar valley	♂	17.5	4.25	3.25
20404	......do	♀	18.5	4.50	4.00
20405	......do	♂	17.5	4.50	3.50
20406	......do	♀	16.0	5.00	4.00
21840	......do	♂	17.5	4.00	3.25
21841	......do	♂	17.25	4.50	3.50

LAGOMYS ROYLEI, Ogilby.

There is one specimen in the collection from Nagmarg, Central Kashmir, taken at an elevation of 9,000 feet. It is a fall specimen and has the middle of the back black in color, produced by the massing together of the long black tips of the hairs. The entire sides of the head and body are rust-colored. The breast is also rust-colored and a broad line of a paler tint extends thence backward above the middle of the belly. Elsewhere the under surfaces are whitish.

Dr. Abbott gives the length of the one specimen obtained as 8 inches, but I think he has included in this the hind feet. The length of the head and body in the dry skin is $6\frac{7}{8}$ inches (173 mm.).

The dimensions of the skull are as follows:

Measurements.	35501, ♀, Nagmarg.
	mm.
Basilar length, from inferior margin of foramen magnum to posterior margin of incisors	34.5
Length of nasals	15.0
Length of cheek teeth	8.0

$\frac{20138}{35501}$. Female. Nagmarg, Central Kashmir, October 22, 1891. 9,000 feet.

LAGOMYS GRISEUS, Blanford.

Blanford does not recognize this species as belonging to the fauna of India, but Dr. Abbott's two specimens agree perfectly with the description and figures of it in the Zoology of the Second Yarkard Mission, and I conclude that they should be assigned here rather than to the closely allied *L. macrotis*. The adult, No. 20396, measured 8¼ inches when fresh, and the younger individual, 7 inches. Dr. Abbott notes the following regarding the species: By no means common at this season at any rate (December); probably hibernates. The Baltis say they are very common, living among the rocks and glacial moraines.

The dimensions of the skull of the adult are as follows:

Measurements.	36814 ♂. 20396.
	mm.
Basilar length*	37.4
Greatest zygomatic breadth	21.5
Least width of frontals	5.0
Length of nasals	16.5
Greatest breadth of nasals anteriorly	5.9
Length of crowns of upper molars and premolars	8.7
Upper incisors to premolars	10.8
Lower incisors to premolars	7.6
Length of crowns of lower molars and premolars	8.2

* From lower margin of foramen magnum to posterior edge of alveolus of large incisor.

$\frac{20396}{36814}$. Male, Doru Nullah, Braldu Valley, Baltistan, December 4, 1891. 10,000 feet.

$\frac{20394}{36815}$. Female, young. Dras Valley, Kashmir, November 12, 1891. 9,000 feet.

CROCIDURA MURINA, (Linnæus).

Of the five specimens of this species collected in Srinagar and the Vale of Kashmir, three were obtained in summer and two in winter. The former are brownish on the back (the tips of the hairs being of that color) while the later are slate-gray. This difference in color, therefore, appears to be seasonal.

In one of the largest specimens, No. 21686, the fifth minute upper tooth is concealed by the fourth and sixth from without, while in others it is visible to a greater or less extent.

Dimensions of three specimens.

Measurements.	20154, ♀. Srinagar.	21686, ♂, Srinagar.	21687, ♀, Vale of Kashmir.
	Inches.	*Inches.*	*Inches.*
Length of head and body	$5\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{7}{8}$
Length of tail	$2\frac{7}{8}$	$3\frac{1}{8}$	$2\frac{7}{8}$

$\frac{20153}{35516}$. Male. Vale of Kashmir. June 29, 1891.
21678. Female. Vale of Kashmir. June 2, 1893.
20398. Male (?). Vale of Kashmir. Winter, 1891–'92.
$\frac{20154}{35517}$. Female. Srinagar. October 29, 1891.
$\frac{21686}{36391}$. Male. Srinagar. May 25, 1893.

CROCIDURA ARANEA, (Linnæus).

One specimen:

$\frac{20152}{35515}$. Female. Mountains of Central Kashmir. September 13, 1891; in pine forest, 10,000 feet.

VESPERUGO (ADELONYCTERIS) SEROTINUS (Schreber).

The specimens of this species differ very much in color from the American form which has been assigned to the same. The tips of the hairs above are pale ashy yellow, giving a hoary appearance. The forearm is much longer, reaching 2.2 inches.

21685. Female (?). Vale of Kashmir, May 29, 1893.
21684. Male. Vale of Kashmir, April 10, 1893.

VESPERUGO PIPISTRELLUS, (Schreber).

Two specimens from the Vale of Kashmir are in the collection.

VESPERTILIO MURINUS, Linnæus.

One alchoholic specimen, No. 21809, female, from the Vale of Kashmir.

In connection with the foregoing catalogue I have thought it desirable to compile a list of all the species of mammals which have been definitely recorded by Blanford, Sterndale, Jerdon, Anderson, Sclater, Scully, Hügel, Lydekker, and other writers, as occurring in the northwestern portion of Kashmir, that is, in the Vale of Kashmir, Baltistan and Gilgit. The list is as follows: *

Mammals of Northwestern Kashmir.

Macacus rhesus.
Macacus rhesus villosus.
Semnopithecus schistaceus.
Felis uncia.
Felis torquata.
Lynx isabellinus.
Herpestes auropunctatus.
Herpestes thysanurus.
Herpestes mungo (?).
Canis lupus.
Canis aureus.
Cyon dukhunensis.

*The names of species included in Dr. Abbott's collection are in italics.

Vulpes montanus.
Mustela flavigula.
Mustela foina.
Putorius erminea.
Putorius subhemachalanus.
Putorius canigula.
Putorius alpinus.
Lutra vulgaris.
Ursus isabellinus.
Ursus thibetanus.
Talpa micrura (?)
Crocidura aranea.
Crocidura murina.
Rhinolophus hipposideros.
Rhinolophus ferrum-equinum.
Megaderma lyra.
Plecotus auritus.
Synotus darjelingensis.
Otonycteris hemprichi.
Vesperugo serotinus.
Vesperugo discolor.
Vesperugo borealis.
Vesperugo pipistrellus.
Harpiocephalus tubinaris.
Vespertilio longipes.
Vespertilio megalopus.
Vespertilio murinus.
Eupetaurus cinereus.
Pteromys albiventer.
Sciuropterus fimbriatus.
Arctomys caudatus.
Sminthus concolor.
Mus rattus.
Mus bactrianus.
Mus sublimis.
Mus arianus.
Mus arianus griseus.
Nesokia bengalensis.
Arvicola roylei.
Arvicola blanfordi.
Arvicola fertilis.
Arvicola montosa.
Arvicola albicauda.
Cricetus phaeus.
Cricetus fulvus.
Cricetus isabellinus.
Hystrix leucura.
Lepus tibetanus.
Lagomys roylei.
Lagomys griseus.
Lagomys macrotis.
Ovis vignei.
Capra sibirica.
Capra falconeri.
Hemitragus jemlaicus.
Nemorhædus bubalinus.
Nemorhædus goral.
Cervus cashmerianus.
Moschus moschiferus.

DESCRIPTION OF A NEW LIZARD (VERTICARIA BELDINGI), FROM CALIFORNIA.

By LEONHARD STEJNEGER,
Curator of the Department of Reptiles and Batrachians.

A RECENT examination of certain specimens of *Verticaria* sent to the Museum for identification made it clear that the specimens from localities north of the Cape St. Lucas region, Lower California, differ in several points, which makes it necessary to regard them as a separate form.

VERTICARIA BELDINGI, new species.

Diagnosis.—Scales bordering gular fold smaller than those on chest between fore legs; frontal usually entirely separated from second supraocular by a row of granules.

Habitat.—Southern California and Lower California, except Cape region.

Type.—U. S. Nat. Museum, No. 11980; Cerros Island, Lower California; L. Belding, collector.

After a careful comparison of three specimens of the present form, viz: the type and two specimens from San Jacinto, San Diego County, Cal., belonging to the museum of the Leland Stanford Jr. University, with 40 specimens from the Cape St. Lucas region, including the types of *Verticaria hyperythra*, I have concluded that the specimens from Cerros Island and Southern California differ in having the scales forming the border of the gular fold considerably smaller than the corresponding scales in *V. hyperythra*, being in the latter of the same size, at least, as the scales covering the chest between the fore legs, while in the new form here described they are perceptibly smaller. I find, moreover, that in 37 out of the 40 specimens of *V. hyperythra* from Cape St.Lucas the frontal shield is in contact with the second supraocular and often with the third as well, while in *V. beldingi* the frontal is separated from all the supraoculars by a complete series of granules. This character is not quite exclusive of *V. beldingi*, since in in a lot of specimens collected by Mr. Belding at La Paz, Lower California (Nat. Mus. No. 12613), there are 3 specimens which in this respect agree with *V. beld-*

ingi, though otherwise they are typical *V. hyperythra*. The character is of considerable importance, however, as it appears to hold in more than 90 per cent. of the specimens.

I am under great obligations to the authorities of the Leland Stanford Jr. University, particularly Dr. Charles H. Gilbert, for the opportunity to examine the two specimens from San Jacinto, as with only one specimen in our own collection I should have been unable to appreciate the difference between the two forms.

I take great pleasure in naming this new species after Mr. L. Belding, whose extensive and excellent herpetological collecting in Lower California as well as in Upper California has never been adequately recognized.

NOTE ON A BLUE MINERAL, SUPPOSED TO BE ULTRAMARINE, FROM SILVER CITY, NEW MEXICO.

By R. L. PACKARD.

SOME TIME ago the newspapers* mentioned the discovery of ultramarine in New Mexico, and Mr. G. P. Merrill, curator of geology in the U. S. National Museum, who was in Silver City, New Mexico, in the early part of 1892, visited the locality where the blue mineral referred to is found, and noted its occurrence. He states that the mineral occurs in irregular veins and streaks in the limestone carrying the silver ore (chloride) which is mined at Chloride Flat near Silver City. The specimens he procured for the Museum exhibit the earthy blue substance (which, on casual inspection, does somewhat resemble ultramarine) intimately associated with calcite, chalcedonic quartz, and a decomposed ferruginous siliceous material which is permeated with calcite, as is also the blue mineral itself; and grains of calcite can be seen mixed with particles of the latter on crushing and examining it with a microscope.

It was found impossible to free the mineral completely from its associated gangue by the Thoulet's solution, and to obtain as pure material as possible for analysis small particles which were free from visible impurities were carefully picked out, larger ones were crushed and gangue and mineral separated by picking over, the blue fragments being again crushed and picked over. The material so obtained was powdered in an agate mortar, treated with hot dilute hydrochloric acid to dissolve out the calcite and other impurities; the powder was filtered off, washed, and then boiled with a strong solution of carbonate of soda, washed thoroughly, dried at 110°, and ground fine for analysis. With every precaution, however, a few scattered grains of a mineral more strongly refracting than the blue one under investigation were observed under the microscope, showing that perfect separation had not been effected. These grains of foreign matter (quartz) are doubtless the cause of the slight differences in the analyses.

* *Iron*, London, Jan. 2, 1892: "A New Discovery of Ultramarine."

The material obtained for analysis as above described is dull, earthy, and of a blue color, resembling vivianite in these respects, but is in the form of a powder. Its grains act feebly on polarized light, but present no crystalline forms. It does not lose its color in hot acids although it is partly decomposed, yielding magnesia. Before the blowpipe it does not color the cold borax bead, becomes white on ignition but does not fuse, and then gives a pink color with cobalt solution. After treatment with HCl it gives no reaction for manganese on fusing with soda. It contains no phosphoric acid or sulphur.

The analyses of different samples varied somewhat for the reasons which have been given above. Three which accord well are as follows:

	I.	II.	III.
Ignition	6.47	6.26	....
SiO_2	62.43	63.19	62.03
MgO	28.53	27.22	28.74
FeO	.99	....	....
Al_2O_3	.25	....	....
Na_2O	.14	....	....
K_2O	.16	....	....
	98.97		

These analyses show a chemical resemblance to talc, although the physical properties of the two minerals are different. One of the analyses (No. XLVII) given in Hintze's Handbuch, under talc, is almost identical with the above. It runs as follows: SiO_2 63.95, FeO 0.60, MgO 28.25, H_2O 6.65, with 0.78 Al_2O_3.

The carbonate accompanying the mineral is rich in magnesia which, with the abundant silica and iron oxide, would supply the materials for its composition.

DESCRIPTIONS OF TWO NEW SPECIES OF CRABS FROM THE WESTERN INDIAN OCEAN, PRESENTED TO THE NATIONAL MUSEUM BY DR. W. L. ABBOTT.

By MARY J. RATHBUN,
Aid, Department of Marine Invertebrates.

A LARGE number of crabs were recently collected by Dr. W. L. Abbott at the islands north of Madagascar. Among them are two new species, both of which represent rare and peculiar genera. The genus *Hypocœlus* of the Cancridæ can be distinguished by the oblong or oval cavity beneath the antero-lateral border of the carapace. Three species have already been described: *H. granulatus*, (De Haan), from Japan, *H. diverticulatus*, (Strahl) [=*Cancer sculptus*, Milne-Edwards, not Herbst], found sparingly from Japan to the Red Sea and Mauritius, and *H. punctatus*, Miers, of which a single specimen is known, from Torres Straits.

The other new form in the Abbott collection is a member of the Thelphusan genus *Deckenia*, the type of which was described by Hilgendorf from the adjacent African continent. This genus differs from other Thelphusidæ in having the efferent branchial channel prolonged to the front, a character in which it approaches the Oxystomata.

HYPOCŒLUS ABBOTTI, new species.

Carapace shaped much as in *H. punctatus* * and strongly lobulated as in that species; but the second lobule near the antero-lateral margin is longer than wide, and the posterior margin of the cardiac region is transverse and is distinctly separated from a small median lobule. The surface is rough with blunt spiniform tubercles, which also border the somewhat truncate frontal lobes and the prominent præorbital protuberances. There is a spine at the inner suborbital angle. The pterygostomian cavity is suboval, wider at its inner than its outer end. The anterior margin is straight for nearly its whole length and is formed by the antero-lateral margin of the carapace. The cavity is crossed by two ridges nearly parallel to the anterior margin, the ante-

* Miers, Crustacea H. M. S. *Alert*, p. 206, pl. XIX, fig. B, 1884.

rior ridge stopping short of the inner margin, the posterior ridge shorter and not reaching the outer margin. The surface of the abdomen and sternum is covered with bead-like tubercles except for irregular eroded channels or pits. The right cheliped (the left one is missing) is massive and tuberculous or spinous. The merus is short and thick, margins tuberculous, inner and outer surfaces smooth, lower surface finely tuberculous. Carpus with lower half of outer surface spinous. Manus with upper surface subtriangular, half as broad as long; outer surface with longitudinal spinous ridges, two of which are continued on the pollex and terminate in two of the five strong teeth (one is terminal) of the prehensile edge. The dactylus bears four spinous ridges on its outer and upper surface and seven teeth on the prehensile edge which are smaller than the propodal teeth and fit closely into the spaces between them. The inner surface of the manus is tuberculous on its proximal lower portion. The ambulatory legs are short and broad; the last two pairs when drawn up, fit into the cavity adjoining the postero-lateral border of the carapace. The meral joints are very broad (in the first pair the width is one-half the length), and are hollowed beneath to receive the two following joints; their anterior distal angles are produced and rounded. The distal end of the propodus is much broader than the adjacent portion of the rather slender and slightly tapering dactylus.

Unfortunately it is impossible to give an accurate description of the natural color of the specimen, as with other crabs it was placed when collected in contact with nudibranch mollusks, which have given it a dark blackish-blue color. The entire surface is coated with a membranous covering apparently epidermic which tends to obscure the tubercles. Where this has been removed with muriatic acid the carapace appears to be blotched with bright red and white. The tips of the spines are white. The carapace is sparingly hairy, the legs are margined with hair, and the subbranchial regions are very hairy.

Measurements.—Length of carapace (of male), 55.5 mm.; width, 76; length of manus, lower margin, 44; depth, 21; width of upper surface, 10; length of merus of last ambulatory leg, upper margin, 16.5; length of carpal joint, 11; length of propodal joint, 6; length of dactylus, 10; width of merus, 6.5; proximal width of propodal joint, 6; distal width, 4; greatest or transverse diameter of pterygostomian cavity, 25; opposite dimension, 11.

Locality.—Aldabra Island. (One male, No. 17753).

A. Milne-Edwards in describing the genus* says that the pterygostomian cavity is concealed by the anterior feet when the latter are folded against the carapace. This is not the case in this species. In no position does the cheliped fit tightly over the cavity. When the cheliped is folded, the upper surface of the manus is continuous with

*Nouv. Arch. Mus. Hist. Nat. Paris, I, 1865, p. 295.

the inner distal portion of the outer face of the carpus. The inner border of this area corresponds in position very nearly with the posterior margin of the pterygostomian cavity; the cavity itself is therefore left uncovered. The only other representative of this genus in the National Museum is a single specimen of *H. diverticulatus*, from Mauritius, in which the cavity is longitudinal, its margin formed by two confluent circles. When the cheliped is folded against the body, the concave upper margin of the manus and anterior carpus crosses the cavity at its middle, concealing the posterior half, and exposing the anterior half.

H. abbotti differs from other species in the double ridge in the pterygostomian cavity, and in the carapace marked with tubercles instead of granulations, rugose lines, or punctæ.

DECKENIA CRISTATA, new species.

Carapace a little more than four-fifths as long as broad, very thick, slightly convex transversely, very convex longitudinally, antero-lateral margins strongly arcuate. There is a prominent tuberculous post-frontal crest, extending across the carapace, sinuous, interrupted at the median line and at the cervical suture, and slightly interrupted behind the base of the eye. The median groove extends backward from the frontal margin to the postfrontal crest, where it divides into two grooves outlining the narrow anterior portion of the mesogastric region. The cardiacal grooves are shallow; the cervical groove is almost longitudinal for a portion of its length, then curves outward and ends at the post-frontal crest. The dorsal surface is punctate, the anterior half is covered with squamiform granules, which, on the anterior branchial regions, become tuberculous and tend to form short ridges. The front is about one-third the width of the carapace, deflexed, tuberculous, three-lobed, median lobe more advanced and much narrower than the lateral, its margin bent towards the horizontal. The margin of the front and orbit is raised, shining and indistinctly granulous. The orbital margin is sinuous, its general direction being outward and forward. The postorbital tooth is acute and more advanced than in *D. imitatrix*. The epibranchial tooth is smaller and not far behind the postorbital; it is followed by a row of about twenty small tuberculous teeth, forming an antero-lateral marginal line which posteriorly curves upward and inward on the carapace. The postero-lateral branchial regions are marked by transverse broken raised lines, which are continued on the subbranchial area. The posterior of these lines is the strongest and is continued further inward on the dorsal surface. The suborbital margin is nearly straight, inclined inward and slightly forward, and is finely toothed, its inner angle thickened and adjoining the end of the efferent branchial channel, which is in advance of the lateral frontal lobe and is visible from above. On the subhepatic region are two tuberculous lines concentric to the orbit. The abdomen of the

female has the first two segments short, the third to the sixth increasing successively in length, the terminal segment large, subtriangular, one-half as long as wide. Eggs very large, $3\frac{1}{2}$ mm. in diameter. The disposition of the antennal region is similar to that of *D. imitatrix*. The antennæ are minute, smaller than in that species, and smaller than the antennulæ. Maxillipeds similar in shape to those of *D. imitatrix;* margin of merus and anterior margin of ischium tuberculous.

The chelipeds are very unequal and rough with transverse squamose lines. The lower and inner margins of ischium and merus are armed with triangular spines; the upper margin of the merus, with teeth which are prolongations of the rugosities of the outer surface. The carpus has a stout inner spine, with a smaller one at its base. The larger hand is deep and swollen; both hands are curved inward and very rough, especially above. Digits with impressed longitudinal lines; very stout in the large cheliped; prehensile edges irregularly toothed and almost touching. The ambulatory legs are longer than in *D. imitatrix*. Joints margined, and with transverse rugose lines which form shallow teeth at the upper margin. Carpal and propodal joints with a double margin above, and two more or less rough longitudinal ridges on the outer surface. Propodal joints with two rows of small appressed spines below. Dactyli flattened, longer and narrower than in *D. imitatrix*, with two rows of sharp spines above and below.

Measurements.—Length of carapace (of female), 29 mm.; width, 34; thickness, 18; width of front, 12; width between postorbital spines, 22.5; width between epibranchial spines, 27; length of propodal joint of cheliped, lower margin, 27; depth, 13.5; thickness, 8.8.

Locality.—Seychelles. (Two females, one with eggs; one young, No. 18064).

This species differs from *Deckenia imitatrix* from Zanzibar in the postfrontal crest, narrower front, rough surface, fewer spines on the carpus, and in so many other respects that the species are not likely to be confounded.

DESCRIPTIONS OF A NEW GENUS AND TWO NEW SPECIES OF AFRICAN FRESH-WATER CRABS.

By Mary J. Rathbun.

Aid, Department of Marine Invertebrates.

The crabs described below were found in mud under boards and timbers by Mr. J. H. Camp at Stanley Pool, Congo, West Central Africa.

Family THELPHUSIDÆ.

PARATHELPHUSA CAMPI, new species.

Carapace subquadrilateral, conspicuously punctate. Depression between the gastric and cardiac regions deep. Protogastric lobes prominent, separated by a median groove which extends backward from the frontal margin. The postfrontal crest begins behind the base of the eyestalk and is continued to the lateral margin; it is finely denticulate and is almost straight, sloping backward and outward. Front a little more than one-third the width of the carapace, deflexed, divided by a very shallow sinus into two lobes, with a raised margin, which is continued to the postfrontal crest. Superior orbital margin sinuous, advanced in its middle portion. Postorbital tooth acute, prominent. Lateral branchial spines three. In one of the two specimens there is a spinule between the first and second spines, and a short fourth spine on the left side. Between the first spine and the postfrontal crest there are two or three spinules forming a short ridge in the same line with the postfrontal crest. From the last spine a raised line extends backward upon the carapace, and is followed by several broken parallel lines. The inferior margin of the orbit is rather deeply rounded below the outer angle; from that point the margin is directed inward and forward; the inner angle is obtuse; the margin is set with a row of bead-like granules. The terminal segment of the abdomen of the female is subtriangular, and the length is nearly half the width. The merus of the maxillipeds is very transverse, the antero-external angle rounded, the antero-internal angle not deeply cut.

Chelipeds of female unequal; merus rugose above, inner margin tuberculous, with a sharp spine just below the margin; carpus with two

spines on the inner margin. Hand slightly inflated; upper margin straight, lower slightly convex. Fingers irregularly toothed and almost touching. Ambulatory legs rather slender, flattened; propodal joints indistinctly spinulous on the margins.

Measurements.—(No. 18065, two females). Length of larger specimen, 21.5 mm.; width, 29.5. Length of smaller specimen, 19; width, 27.

This species, in its three lateral teeth, resembles *P. pœcilei*, A. Milne-Edwards, but differs from that species in its narrower and more quadrate carapace and interrupted postfrontal crest.

ERIMETOPUS, new genus.

Carapace arcuate anteriorly, quadrate posteriorly, moderately convex. Front advanced beyond the antennular cavities, composed of two distinct rounded lobes. Orbits narrow; eye-stalks tapering to the extremity. Postfrontal crest short and inconspicuous, or wanting. Lateral margins spinous. The merus of the maxillipeds is transverse, the antero-external angle rounded, the palpus articulating at the internal angle, which is very slightly notched. Chelipeds with a row of spines on the anterior margin of the carpus. Ambulatory legs with margins spinous.

ERIMETOPUS SPINOSUS, new species.

Carapace about four-fifths as long as broad, convex longitudinally, postero-lateral margins long, sloping slightly inward and backward, antero-lateral margins arcuate. The cardiac region and the posterior portion of the gastric region are outlined by shallow depressions. Front about one-third the width of the carapace, advanced, two-lobed, lobes separated by a broad V-shaped sinus. Margin of front and orbits granulous. Orbits well-defined, the outer angle a sharp incurved spine. There are two protogastric lobes, little elevated and often not discernible, except by two transverse lines of a lighter color. A very shallow median groove extends backward from the frontal margin and forks directly behind the protogastric lobes. The postfrontal crest, when present, is short, arcuate, tuberculous, and indistinct. It begins back of the cornea and for a short distance is nearly straight, directed outward and slightly forward, then curves almost parallel to the antero-lateral margin. In most specimens, however, the crest is obsolete, indicated only by the smoothly-rounded elevation behind the orbit, Antero-lateral margin with a row of from 5 to 8 spines next the orbit, of which the orbital spine is the largest. The spines are irregular in size and position. On the anterior branchial region are 5 or more marginal spines separated by a space from the hepatic spines; the anterior is by far the larger, and is sometimes bifid. The others decrease in length posteriorly. The suborbital margin is granulous except at the notch beneath the postorbital spine. The abdomen of the female covers the sternum.

Chelipeds in the female unequal. The margins of the merus are spinulous, the upper margin with a sharp spine near the carpus, the inner surface tuberculous at its base, the lower surface with a transverse tuberculous ridge at its distal end. The carpus has two strong spines on its inner margin, and a row of about 7 smaller spines on the anterior margin, two of which are close to the condyle of the manus and are separated by a wide interval from the remaining spines. Sometimes one of the spines is bifid, and occasionally additional spinules occur on the upper surface behind the marginal spines. The manus is slightly swollen, with a convex lower margin and almost straight upper margin, which sometimes in the smaller cheliped has a small sharp spine at the distal end; in a few specimens there are one or two spines at the proximal end. Fingers irregularly dentate on their prehensile edges and slightly gaping. The ambulatory legs are rather broad, flattened; meral joints with two spines at the distal end; carpal and propodal joints strongly spined above; carpal joints with distal spines in the first pair and often in the second and third pairs; propodal joints with a few spines below; dactyli with four rows of spines.

Measurements.—(No. 18066, female.) Length, 30.5 mm.; greatest width, 38; width between postorbital spines, 19.

The male is unknown.

This species can be distinguished from other Thelphusidæ by its produced, round-lobed front, narrow orbits, and numerous spines.

AN ANALYSIS OF JADEITE FROM MOGOUNG, BURMA.

By Oliver C. Farrington.

The specimen of jadeite here described (No. 81306), was obtained from Mr. James Wickersham, of Tacoma, Washington, he having forwarded it to Major J. W. Powell, Director of the U. S. Geological Survey, for examination. The material sent consisted of fragments taken from a jade bowlder procured in Burma by Rev. J. A. Friday, who was for ten years a missionary in the vicinity of Mogoung. As these fragments seemed to be typical specimens of the unworked Burmese jadeite, and came from a source which could leave no doubt as to their genuineness, it was thought desirable by Prof. F. W. Clarke, Chief Chemist of the Survey, that a somewhat extended examination should be made of them, and they were accordingly placed in the hands of the writer for this purpose.

Concerning the mode of occurrence of the jade, the information which Mr. Friday obtained is largely corroborative of the previously published statements of Dr. Anderson*, and since these give an excellent description of the Mogoung "diggings," we quote them here:

A stone known in commerce as jade is extensively worked in the Mogoung district of Upper Burma.

The mines, or rather pits, are in a valley 25 miles southeast of Meinkhoom, as many as 1,000 men being engaged in digging, during certain seasons of the year. The stone is found in the form of more or less rounded bowlders, associated with others of quartz, etc., embedded in a reddish yellow clay. The pits are not after any particular plan and none exceed 20 feet in depth. They occur all over the valley and at the base of the hill. The masses which are removed are of considerable size, and I saw some in a godown of a merchant at Rangoon so large that it required three men to turn them. * * * The greater portion of the Mogoung stone was formerly exported to Momien, in Yunan, and a considerable amount still goes there. It is possible therefore that the specimens of jadeite from China, of which analyses have been published, were originally obtained in Burma. It appears however that there are jade mines in Yunan also, as well as in other provinces of China.

In regard to the methods employed by the natives in working the jade, Mr. Friday states that they break, by heating, the bowlders which

* Geology of India, Part IV, p. 94.

contain it, until a suitable piece is found. This is then laid aside to be sold to the caravans which come to the mines for this purpose from China and other countries, or it is worked by the native artisans.

These latter cut the bowlders with a saw made of a bow of bamboo, strung with a steel wire composed of finer wires twisted together. Keeping the stone wet by water dripping from above, they sit down before it and with this primitive tool saw away day after day till they have reduced it to the desired shape. This process seems painful and laborious enough, but before the use of steel was known, its difficulties must have been far greater.

The specimens examined had in general a pure white color, but contained occasional spots of light green. For the purpose of analysis, only the white portions were used.

The analysis gave the following results:

	I.	II.	Mean.	Ratio.	Theory for NaAl $(SiO_3)_2$
SiO_2	58.99	59.45	59.22	.987 4	59.4
Al_2O_3	24.77	24.32	24.55	.241 }	25.2
Fe_2O_3	.32	.36	.34	.002 } 0.98	
CaO	.14	.22	.18	.003 }	
MgO	tr.	tr.	....	} 0.96	
Na_2O	14.51	14.42	14.46	.233 }	15.4
Ign	1.14	1.15	1.14	....	....
	99.87	99.92	99.89	....	100.0
G. =	3.3308				

The state of oxidation of the iron was not determined. Manganese was probably present in minute quantity, as indicated by the color of the sodium carbonate fusion, but it was impossible to precipitate a weighable amount. The analysis shows no essential differences from those made of similar material by Schoetensack* and Damour,† except in the fact that the percentages of CaO and MgO are very small. As neither of these molecules would be present in a typical jadeite, the material analyzed may therefore be considered as unusually pure, and the close approximation of the ratios to those required by the formula tends to confirm the correctness of the latter.

Macroscopically the jadeite is subtranslucent, exhibits a homogeneous, fine-grained texture, and is very tough. Under the microscope it is seen to be made up of small irregular granules and flat, parallel fibers closely interwoven. The granules rarely exceed 0.06 mm. in diameter and the fibers have an average width of only 0.05 mm. with a varying length of from 0.15 mm. to 0.6 mm. In this fineness of grain the material differs from the Monghoung jadeite described by Schoetensack, as he states that to consist of "grobkörnigen und auch langgezogenen Lamellen." The absence of distinct crystal forms renders optical orienta-

* Die Nephritoide des mineralogischen und des ethnographisch-prähistorischen Museums der Universität Freiburg im Breisgau. Inaug. Dis., Berlin, 1885.

† Bull. Soc. Min., IV, 1881, 157.

tion difficult, but occasional sections show parallel cleavage lines giving an extinction angle of 35°. Others showing cleavage lines nearly at right angles give an angle of extinction =0°. A form with cleavage cracks making an angle of 63°, evidently from the orthodiagonal zone, shows the emergence of an optic axis with finely colored rings. Indications of an alteration process appear in some portions of the section in a clouding and opacity extending inward from the cleavage cracks. These portions under a higher power exhibit a finely fibrous structure which is developed in the individual granules and which suggests that alteration to amphibole is taking place. As compared with the American jadeites described by Clarke and Merrill* the Mogoung specimen shows chemical and optical differences which correspond to those already mentioned, as distinguishing it from the jadeites described by Schoetensack and Damour (*loc. cit.*), viz: smaller percentages of the elements replacing Na and Al and microscopically a finer texture.

* Proc. U. S. Nat. Mus., XI, 1888, 115.

NOTES ON SOME SKELETONS AND SKULLS OF PORPOISES OF THE GENUS PRODELPHINUS, COLLECTED BY DR. W. L. ABBOTT IN THE INDIAN OCEAN.

By Frederick W. True,

Curator of the Department of Mammals.

During his recent cruise among the islands north of Madagascar, Dr. Abbott collected three complete skeletons and two skulls of porpoises. These, with notes and measurements, he has very kindly presented to the National Museum. The notes include a description of the coloration of each specimen captured, and thus it is possible to correlate the external characters with those of the skeleton. This is a most important matter, and especially so in this instance, as the specimens all belong to the genus *Prodelphinus*, than which there is no more difficult group among the Delphinidæ.

It is with considerable diffidence that I attempt to identify Dr. Abbott's specimens with any of the described species of *Prodelphinus*. The practice of establishing species on single skulls was formerly followed in connection with this genus as elsewhere in the Delphinidæ. But it has been pointed out, especially by Sir William Flower, that in a series of skulls of *Prodelphinus*, while those at the extremes may show differences which would entitle them to be regarded as specifically distinct, these differences blend together in the middle of the series. Hence, in considering the identity of any particular skull, it is often doubtful to which one of several nominal species it should be referred.

Much new light has been thrown on the relationships of the species of *Prodelphinus* by Dr. Lütken in his most valuable work upon this and other genera of Delphinidæ,* published in 1889. Having in his possession an excellent collection of skeletons of various species of *Prodelphinus*, accompanied by color-notes, measurements, etc., he was able to furnish much fuller information than any previous writer. For several species he has given the number of vertebræ, the position in the ver-

*Bidrag til Kundskab om de tre pelagiske Tandhval-Slaegter *Steno, Delphinus* og *Prodelphinus*. Vidensk. Selsk. Skr., 6. Raekke, naturvid. og math. Afd., V, 1, 1889. At the time a copy of this paper reached me, my own work on the Delphinidæ (A Review of the Family Delphinidæ. Bulletin of the U. S. National Museum, No. 36, 1889) was passing through the press, and I was unable, therefore, to make as good use of it as I should have desired to do.

tebral column in which the various processes and foramina originate and disappear, the number of phalanges, the absolute and relative dimensions of the skull, and many other important details. In treating of Dr. Abbott's specimens I shall follow the method originated by Dr. Lütken, thereby supplying the means for further comparisons.

In spite of certain differences in coloration, etc., I regard all of Dr. Abbott's specimens as belonging to the same species. They seem to me identical with the specimens (Nos. 8 and 3) which Dr. Lütken identified (rightly I believe) with Gray's species *attenuatus*. The question of their relationship to other species I shall pass over for the present, and shall proceed to describe them in detail. The material is as follows:

a. Complete skeleton of a male, 6 feet 2 inches long, from off the Amirantes Islands; obtained February 12, 1893. No. 36049.

b. Skull of a female, 7 feet long, from off the Amirantes Islands; obtained February 15, 1893. No. 36050.

c. Skull of a female, 6 feet 1 inch long, from off Alphonse Island. No. 36131.

d. Complete skeleton of a female, 6 feet 2 inches long, from off Providence Island; obtained August 12, 1892. No. 36051.

e. Complete skeleton of a male, 5 feet 6½ inches long, from off Johanna Island; obtained January 15, 1893. No. 36048.

The external coloration is given by Dr. Abbott as follows:

No. 36049, ♂, Amirantes Islands.—Above, blackish; below, light gray or ashy, with a sharply-defined line of division between the two colors. Belly speckled with black spots of the size of barley grains. "Black portion saddle-shaped, narrowing in front, passing to the base of the rostrum, and 4 inches above the eye. A darkish line passes through the eye. Rostrum black above, gray beneath, with black spots the size of barley grains."

No. 36050, female, Amirantes Islands.—Above, dark gray, speckled with white; beneath, light gray. (Whether the colors are sharply separated is not specified in this instance.)

No. 36131, female, Alphonse Island.—Color dark gray or ashy; above, nearly black; beneath, light, with a sharply-defined line of demarkation. Belly not speckled.

No. 36051, female, Providence Island.—Dark gray or ashy; darkest on the back, speckled with white below.

No. 36048, male, Johanna Island.—Back, dark ashy; beneath, pale ashy, speckled with irregularly-shaped dark ashy spots the size of maize grains. Line between dark and light parts sharply defined, especially on the head, where it passes 3 inches above the eye to the base of the rostrum.

It will be observed that the ground-color in all these specimens is quite uniform, and that the chief difference is in the spotting. It is also worthy of remark that the spots of the females are white, while those of the males are black or dark gray. This may be accidental, but the idea that the difference in the color of the spots is a sexual character derives some support from the fact that the type of Gray's *D. punctatus* (considered by me as identical with *P. attenuatus*), which was a female, had white spots. Dr. Lütken* does not refer to the presence of spots in

*L. c., p. 45.

this species. The color of his No. 8, however, was "very dark above and ashy gray below," in which it agrees, so far as the ground-color is concerned, with Dr. Abbott's specimens.

Bringing together in tabular form the measurements of the exterior given by Dr. Abbott and those of Dr. Lütken's No. 8, we have:

Table measurements.

Catalogue number.	Sex.	Total length.		Tip of rostrum to base of dorsal.	Height of dorsal.	Width of flukes.	Length of pectoral.	Girth immediately behind pectorals.	Girth at anterior base of dorsal.	Girth at posterior base of dorsal.
		Ft.	*In.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
36050	♀	7	0	....	....	....	....	....	....	....
36049	♂	6	2	33	$5\frac{1}{4}$	17	10	$31\frac{1}{2}$	....	....
36051	♀	6	2	....	$6\frac{1}{4}$	....	....	....	....	....
36031	♀	6	1	....	$6\frac{3}{4}$	....	....	....	38	$31\frac{1}{2}$
36048	♂	5	$6\frac{1}{2}$	....	6	15	9	....	....	....
Lütken's No. 8	♀	5	$7\frac{1}{2}$	$31\frac{1}{2}$	....	....	....	....	35	....

The number of teeth in the different skulls is as follows: No. 36059, female, $\frac{38-38}{36-38}$; No. 36049, male, $\frac{38-38}{38-37}$; No. 36051, female, $\frac{39-39}{39-39}$; No. 36031, female, $\frac{44-43}{40-41}$; No. 36048, male, $\frac{41-39}{39-40}$. The total number, therefore, varies from 150 to 168. The number in Dr. Lütken's two specimens was 147 and 163, respectively.

In the three skeletons collected by Dr. Abbott and the two of Dr. Lütken, the number and the divisions of the vertebræ are as follows:

No. 36049, ♂.—C. 7; D. 16; L. 20; Ca. 36=79.
No. 36051, ♀.—C. 7; D. 16; L. 20; Ca. 35=78.
No. 36048, ♂.—C. 7; D. 16; L. 20; Ca. 36=79.
Dr. Lütken's:
No. 8, ♀.—C. 7; D. 15; L. 21; Ca. 36=79.
No. 3, (?).—C. 7; D. 15; L. 21; Ca. 38=81.

The amount of variation here shown is very slight for members of this family. In the first and third of Dr. Abbott's specimens, the last pair of ribs is rudimentary, while in the second (No. 36051) there are two rudimentary ribs on the left side and one on the right. Each of Dr. Lütken's specimens possessed a single pair.

The characters connected with to the relative position of the processes and foramina of the vertebræ next claim our attention, and here again the amount of variation is small:

Characters.	36049, ♂.	36031, ♀.	36048, ♂.	Lütken's 8, ♀.	Lütken's 3.
First vertical arterial foramen is in vertebra number	55	56	57	58	57 or 58
Last distinct transverse process is on vertebra number	59	60	60	62	61
Last distinct neural spine is on vertebra number	66	67	66	67	67 or 68
Vertebræ without metapophyses	31st to 46th	33d to 42d	33d to 45th	33d to 44th	29th to 44th

The last relationship, that of the number and portion of the metapophyes is, perhaps, of little importance, as these processes die away very gradually and different observers might disagree as to the real number.

In the number of phalanges, Dr. Lütken's two specimens show a considerable difference, while those of Dr. Abbott agree well among themselves. The formulæ (the metacarpals being excluded) are as follows:*

Digits.	36049, ♂.	36051, ♀.	36048, ♂.	Lütken's No. 8, ♀.	Lütken's No. 3.
	Phalanges.	*Phalanges.*	*Phalanges.*	*Phalanges.*	*Phalanges.*
First digit	1	1	1	2	0
Second digit	8	8	8	8 (9)	7
Third digit	5	5	5	6	5
Fourth digit	2	2	2	2	2
Fifth digit	0	1	1	1	1

The five skulls agree well in proportions, the rostrum being 60 to 61 per cent. of the total length in all. The breadth of the rostrum at its base, compared with its length, varies from 37.5 per cent. in the largest skull to 40.5 per cent. in the smallest. Other proportions may be learned from the following table of measurements:

Measurement.	36050, ♀, Amirantes Islands.	36049, ♂, Amirantes Islands.	36051, ♀, Providence Island.	36031, ♀, Alphonse Island.	36048, ♂, Johanna Island.	Lütken's No. 8, ♀.	Lütken's No. 3.	Type of *P. attenuatus*, Brit. Mus. 347*b*.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Total length from tip of rostrum to surface of occipital condyles	415	407	403	397	379	400	400	383
Length of rostrum	253	251	244	241	222	245	243	229
Breadth of rostrum at its base	95	95	91	96	90	90	84	87
Length of temporal fossa	60	65	64	65	63	....	....	65
Vertical height of temporal fossa	47	56	53	56	54	....	....	50

The species *P. attenuatus*, (Gray), with which Dr. Abbott's specimens are here identified, is one of a group of nominal species, thirteen or more in number, which I regarded in my Revision of the Delphinidæ † as probably reducible to three. With *P. attenuatus* I associated *Delphinus pseudodelphis*, Wiegmann; ‡ *Steno capensis*, Gray; § and *Clymene punctata*, Gray. ‖ The first of these names, *D. pseudodelphis*, appeared originally as the legend of a plate in Schreber's Säugethiere, representing a skull of the same general characteristics as those described herein. No description of the type-skull has been published, so far as I am

* By referring to Dr. Lütken's illustrations I find that he apparently includes the metacarpals with the phalanges proper. In quoting his formulæ, therefore, I have subtracted one from the number given for each digit.

† Bull. U. S. Nat. Mus., No. 36, 1889, p. 67.

‡ Schreber's Säugethiere, pl. 358.

§ Proc. Zool. Soc., London, 1865, p. 522.

‖ *Loc. cit.*, p. 738.

aware, though Wagner, on the authority of Troschel* gives the number of teeth as 40 above and 37 below. The name will, therefore, remain as a *nomen nudum*, except for those who regard a name attached to a plate as having a status in systematic nomenclature. The plate must have appeared before 1841, and had it been accompanied by a description, the name would have priority over Gray's *attenuatus*.†

The skull upon which Gray based his *Steno capensis* has been considered by Sir William Flower and myself as specifically identical with his *attenuatus*, and as the description was not published until 1865, the former name, of course, becomes a synonym of the latter.

Gray's *Clymene punctata*,‡ the type-skull of which I examined in the Liverpool public museum, appears to me to be also a synonym of *P. attenuatus*. I did not have an opportunity to count the vertebræ, however, or to note the relative positions of the foramina, and it is possible that differences will be found here which are not correlated in the skull. It is also to be noted that in the figure of the exterior published by Gray,§ a band of light color passes obliquely across the back near the base of the caudal fins. No such color-marking is mentioned in Dr. Abbott's notes or elsewhere, and it may constitute a distinction of important, though I am disposed to regard it as an individual variation.‖

* Schreber's Säugethiere, 7[er] Th., 1846, p. 332.

† Wagner states (Schreber's Säugethiere, 7[er] Th., 1846, preface) that Weigmann died before completing his work on the cetacea for the *Säugethiere*. The plate must have been issued as early as 1841, however, as Schlegel refers to it in his *Abhandlungen aus dem Gebiete der Zoologie*, of that date, and assigns to the species a skull in the Leyden collection.

‡ Described in 1865.

§ Catalogue of Seals and Whales, 1866, p. 398, fig. 101.

‖ NOTE.—In my Revision of the Delphinidæ, p. 61, I make the statement that the genus *Prodelphinus* is distinguished from *Tursiops* by its *less* numerous teeth. The opposite, of course, is intended.

DESCRIPTION OF NESTS AND EGGS OF SOME NEW BIRDS, COLLECTED ON THE ISLAND OF ALDABRA, NORTHWEST OF MADAGASCAR, BY DR. W. L. ABBOTT.

By Charles Bendire,
Honorary Curator of the Oological Department.

Among the interesting and varied collections of natural-history specimens lately received from Dr. W. L. Abbott, were a few nests and eggs, and the following are believed to be still undescribed and new to science:

IXOCINCLA MADAGASCARIENSIS ROSTRATA, Ridgway.

Two nests and eggs of this new subspecies were taken on December 22 and 31, 1892, respectively. The nests are rather slight structures and are composed externally of fine rootlets, small twigs, dry leaves, and plant fibers, and lined with finer materials of the same kinds and dry grasses. Both nests were placed in crotches of thorny shrubs in the jungle and about 8 feet from the ground. One of them, the type-specimen, No. 26200, U. S. National Museum collection, measures 3¾ inches in depth by 4 inches in outer diameter. The inner diameter is 3 inches by 1¾ inches deep.

The eggs, No. 26199, U. S. National Museum collection, set ½, measure .99 by .70 and .95 by .71 inch, and No. 26200, a single egg measures .99 by .68 inch. They are ovate in shape, the shell is close-grained and rather glossy. The ground color is vinaceous pink and is profusely spotted and blotched with different shades of claret brown, vinaceous rufus and lavender, and the markings are heaviest about the larger ends of the eggs where they form a wreath.

BUCHANGA ALDABRANA, Ridgway.

The collection made by Dr. Abbott contains 3 sets of eggs and 2 nests of this species. The nests are very neatly and firmly constructed of small fine twigs well interlaced with each other and are lined with finer materials of the same kind. They are rather shallow for their size and are usually placed on a horizontal branch of a casuarina tree at no very great height, varying from 5 to 10 feet from the ground.

The type specimen No. 26191, U. S. National Museum collection, taken November 18, 1892, measures externally $5\frac{1}{2}$ in diameter by $2\frac{1}{2}$ inches in depth. Inner diameter 3 inches by $1\frac{1}{4}$ in depth.

The shell of these eggs is closely granulated, feels smooth to the touch, and is without luster. The ground color is a rich cream with a pinkish tint, and this is sparingly marked with a few scattered spots of cinnamon rufous and brick-red, and one or two specimens show also a few lavender dots. The markings, few as they are, are generally heaviest about the larger end of the egg. The measurements of the eggs are as follows:

No. 26189, U. S. National Museum collection, set $\frac{1}{3}$, taken December 4, 1892, is 1.05 by .76, 1.04 by .75, and 1.03 by .75 inches.

No. 26190, set $\frac{2}{3}$, taken November 18, 1892, is 1.04 by .74, 1.03 by .74, and 1.02 by .74 inches.

No. 26191, set, $\frac{3}{2}$ taken on the same date, is 1.05 by .78 and 1.03 by .78. In shape they vary from ovate to short ovate.

FOUDIA ALDABRANA, Ridgway.

This new species is represented by two nests and four sets of eggs. The nests, considering the size of this bird, are large and well constructed; open on the side and partially domed. They are externally composed of small twigs, some with leaves still attached, weed stems and coarse grasses, and lined with finer grasses. The entrance is on the side. The outer diameter of the type specimen, No. 26193, U. S. National Museum collection, taken December 10, 1892, is 9 by 7 inches, inner diameter, 3 by $2\frac{3}{4}$ inches. This nest was placed in a mangrove. The eggs of this new species are pale glaucous green in color, unspotted and elongate ovate in shape. The shell is rather thin and glossy.

No. 26192, U. S. National Museum collection, set $\frac{1}{3}$, taken November 27, 1892, measures .83 by .58, .82 by .59 and .79 by .58 inches.

No. 26193, set $\frac{2}{2}$, taken December 10, 1892, measures .79 by .58 and .75 by .59 inches.

No. 26194, set $\frac{3}{3}$, taken November 13, 1892, measures .80 by .56, .81 by .56 and .81 by .57 inches.

No. 26195, set $\frac{4}{2}$, taken December 10, 1892, measures .81 by .55 and .81 by .55.

ROUGETIUS ALDABRANUS, Gunther.

This rail is represented by 2 nests and several probably incomplete sets of eggs. Nest No. 26180, U. S. National Museum collection, the type taken on December 17, 1892, is very loosely constructed of small twigs and plant stems, and was placed in a dense clump of long grass and scrub 18 inches from the ground. The nest measured 10 inches in outer diameter by 7 inches in depth, and the cavity $4\frac{1}{2}$ by $3\frac{3}{4}$ inches in depth, so that only the head of the female protruded from the nest as she sat upon the eggs.

Nest No. 26179, U. S. National Museum collection, taken December 20, 1892, is composed of finer materials, principally dry grasses. It was placed on the ground in a cavity of coral rock, which, according to Dr. Abbott, appears to be the favorite nesting site for this species, the remaining sets of eggs having all been taken in such situations, these cavities being usually nearly filled with small twigs and dry grasses, and the nests were usually concealed by long, tangled bunches of growing grass.

The shell of these eggs is strong, finely granulated, and moderately glossy, and in shape they vary from ovate to elongate ovate. The ground color is creamy white, sparingly dotted with fine spots of liver-brown, vinaceous and lavender, which are usually heaviest about the larger end of the egg.

The measurements of these eggs are as follows:

No. 26178, U. S. National Museum collection, set $\frac{1}{4}$, taken December 22, 1892, 1.60 by 1.19, 1.69 by 1.22, 1.73 by 1.20, 1.69 by 1.23 inches.

No. 26179, set $\frac{2}{2}$, taken December 20, 1892, 1.67 by 1.15 and 1.70 by 1.11 inches.

No. 26180, set $\frac{3}{2}$, taken December 17, 1892, 1.68 by 1.19 and 1.69 by 1.15 inches.

No. 26181, set $\frac{4}{2}$, taken December 13, 1892, is 1.75 by 1.17 and 1.87 by 1.15 inches.

No. 26182, set $\frac{5}{3}$, taken December 18, 1892, is 1.67 by 1.17, 1.65 by 1.05. and 1.68 by 1.16 inches.

NOTES ON THE CRABS OF THE FAMILY INACHIDÆ IN THE UNITED STATES NATIONAL MUSEUM.

By MARY J. RATHBUN,

Aid, Department of Marine Invertebrates.

IN THIS paper two new genera and eight new species are described. No attempt has been made to give a complete list of the specimens in the Museum. Only those described species are noticed for which it was possible to record new localities or add notes to supplement original descriptions and aid in identification. The repetition of matter which has already appeared in the proceedings of the Museum and the bulletins and reports of the U. S. Fish Commission has been avoided. The following is a list of species which appear in this paper. Those marked with a * are species described by Stimpson, the types of which were destroyed in the Chicago fire, and which were unknown from that time until rediscovered by the *Albatross:*

List of species.

Leptopodia sagittaria, (Fabricius).
debilis, Smith.
Metoporhaphis calcaratus, (Say).
Achæus tuberculatus, Miers.
trituberculatus, new species.
Podochela riisei, Stimpson.
spatulifrons, A. Milne-Edwards.
* hypoglypha, (Stimpson).
* lamelligera, (Stimpson).
macrodera, Stimpson.
gracilipes, Stimpson.
spinifrons, new species.
Collodes depressus, A. Milne-Edwards.
robustus, Smith.
leptocheles, new species.
(doubtfulspecies.)
* Batrachonotus fragosus, Stimpson.
brasiliensis, new species.
nicholsi, new species.
Euprognatha rastellifera, Stimpson.
rastellifera spinosa, new subspecies.
gracilipes, A. Milne-Edwards.
Arachnopsis filipes, Stimpson.
Apocremnus septemspinosus, A. Milne-Edwards.
Inachoides intermedius, new species.
Anasimus latus, new species.
Eurypodius latreillei. Guérin.
Oregonia gracilis, Dana.
Anamathia crassa, A. Milne-Edwards.
hystrix, (Stimpson).
umbonata, (Stimpson).
Trachymaia cornuta, A. Milne-Edwards.
Lispognathus thomsoni, (Norman).
HOLOPLITES armatus, (A. Milne-Edwards).
Chorinus heros, (Herbst).
Trichoplatus huttoni, A. Milne-Edwards.
Anomalothir furcillatus, (Stimpson).
* Mocosoa crebripunctata, Stimpson.
Sphenocarcinus corrosus, A. Milne-Edwards.
Simocarcinus simplex, (Dana).
ECHINŒCUS pentagonus, new genus and species.
Epialtus bituberculatus, Milne-Edwards.
productus, Randall.
(Antilibinia) dentatus, (Milne-Edwards).
marginatus, (Bell).
nuttallii, (Randall).
Pugettia gracilis, Dana.
richii, Dana.
quadridens, (De Haan).
foliata, (Stimpson).
Acanthonyx petiverii, Milne-Edwards.
Neorhynchus depressus, Bell.
Pyromaia cuspidata, Stimpson.
Loxorhynchus grandis, Stimpson.
crispatus, Stimpson

Family INACHIDÆ.

Subfamily LEPTOPODIÏNÆ.

LEPTOPODIA SAGITTARIA, (Fabricius).

Cancer sagittarius, FABRICIUS, (Entom. Syst., II, p. 442, 1793).

Leptopodia sagittaria, LEACH, Zool. Misc., II, p. 16, pl. LXVII, 1815.—A. MILNE-EDWARDS, Crust. du Mexique, p. 172, 1878 (partim), and synonymy, except *L. sagittaria*, MLINE-EDWARDS and LUCAS, and *L. debilis*, SMITH.

Localities.

From off Cape Hatteras to the Caribbean Sea; U. S. Fish Commission steamer *Albatross*:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fath.	Temp.	Materials.	
		° ′ ″	° ′ ″		° F.		1884.
6934	2142	9 30 15	76 20 30	42	....	gn. M. S.	Mar. 23
							1885.
17524	2311	32 55 00	77 54 00	79	59. 1	crs. S. bk. Sp.	Jan. 5
9459	2315	24 26 00	81 48 15	37	....	Co	15
9464	2316	24 25 30	81 47 45	50	74	....	15
9467	2317	24 25 45	81 46 45	45	75	Co	15
9475	2318	24 25 45	81 46 00	45	75	Co	15
14975	2354	20 59 30	86 23 45	130	....	Co	22
17401	2362	22 08 30	86 53 30	25	....	Co. S.	30
17405	2363	22 07 30	87 06 00	21	....	wh. R. Co	30
17374	2365	22 18 00	87 04 00	24	....	wh. R. Co.	30
9602	2370	29 18 15	85 32 00	25	....	crs. gy. S. brk. Sh.	Feb. 7
9613	2372	29 15 30	85 29 30	27	....	G	7
14976	2373	29 14 00	85 29 15	25	....	Co	7
17525	2374	29 11 30	85 29 00	26	....	S. G. brk. Sh.	7
9689	2387	29 24 00	88 04 00	32	....	S. G. brk. Sh.	Mar. 4
17402	2390	29 27 30	87 48 30	30	....	crs. S. bk. Sp. Sh.	4
17403	2405	28 45 00	85 02 00	30	....	gy. S. brk. Co	15
17375	2406	28 46 00	84 49 00	26	....	crs. S. Co	15
17404	2411	26 33 30	83 15 30	27	....	fne. wh. S. bk. Sp.	18
11303	2413	26 00 00	82 57 30	24	....	fne. S. bk. Sp. brk. Sh	19
9862	2417	33 18 30	77 07 00	95	65. 8	fne. gy. S	Apr. 2
17373	2596	35 08 30	75 10 00	49	....	gy. S.	Oct. 17
11219	2604	34 37 30	75 39 45	34	....	yl. S. brk. Sh	18
17526	2616	33 42 45	77 31 00	17	....	S. P.	20
11227	2617	33 37 30	77 36 30	14	....	crs. yl. S. brk. Sh.	20
11232	2621	33 34 00	77 42 00	9	....	gy. S. brk. Co.	20
							1886.
11379	2640	25 05 00	80 15 00	56	....	Co. S.	Apr. 9

St. Thomas; steamer *Albatross* (7653).

Brazil; Hartt Explorations:

Maranhão, 2 fathoms, pebbly; Derby and Wilmot, 1870.

Mar Grande, Bay of Bahia; Richard Rathbun, 1875–'77.

Periperi, Bay of Bahia; R. Rathbun.

Bay of Rio de Janeiro, dredged, shallow water; R. Rathbun.

LEPTOPODIA DEBILIS, Smith.

Leptopodia debilis, SMITH, Rept. Peabody Acad. Sci. for 1869 and 1870, p. 87, 1871.

Twenty specimens were collected by the steamer *Albatross* on the coast of Lower California.

These specimens agree in having the hand shorter and broader than in east coast specimens of *L. sagittaria*, and the fingers proportionally longer. The propodus is usually about twice the length of the dactylus and varies to $2\frac{1}{2}$ times that of the dactylus in the largest specimen; in *L. sagittaria* the propodus is usually about $2\frac{2}{3}$ times the length of the dactylus, but varies from $2\frac{1}{2}$ to $3\frac{1}{2}$ times. The ambulatory legs are

shorter in the west coast forms. Those of the first pair are from 6 to 7½ times the length of the carapace, while in the Atlantic species they are from 8 to 8⅔ times the length of the carapace. The rostrum is shorter in the specimens of *L. debilis* in this collection than in most of those of *L. sagittaria*. The rostrum is usually about the same length as the carapace or exceeds it but little, in two instances reaching a length of 1⅓ times the carapace. Prof. Smith, however, describes the rostrum of *L. debilis* as about twice as long as the posterior portion of the carapace.

In our specimens the surface is more pubescent than in *L. sagittaria*, especially the chelipeds of adult forms, and the carapace is usually more swollen at the branchial regions and the rostrum more upturned.

A. Milne-Edwards considers the *Leptopodiæ* from the west coast of Mexico and Central America as the same species as those from the east coast, setting aside as distinct the Chilean form, the *L. sagittaria* of Milne-Edwards and Lucas, and calling it *L. modesta;* consequently his insertion on the same page of the *L. sagittaria* of Milne-Edwards and Lucas in the synonymy of *Leptopodia sagittaria* is erroneous. Some of the specimens from the Gulf of California so resemble the figure given in d'Orbigny's "Voyage" that it may be proved that a single species inhabits the west coast of America, which, in the present state of our knowledge, it seems best to consider distinct from *L. sagittaria.*

The following are the dredging stations at which this species was obtained:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fath.	Temp.	Materials.	
		° ′ ″	° ′ ″		° F.		1889.
17322	3002	25 02 15	110 43 30	17	....	S. Sh.	Mar. 17
16024	3005	25 02 45	110 43 30	21	....	S. Sh. Coralline.	17
18067	3014	28 28 00	112 04 30	29	62. 9	gy. S.	23
15544	3026	31 22 00	114 07 45	17	65. 2	G. brk. Sh.	25
17323	3041	24 35 30	112 05 00	27	64. 5	fne. gy. S.	Apr. 9

METOPORHAPHIS CALCARATUS, (Say).

Leptopodia calcarata, SAY, Jour. Acad. Nat. Sci. Phila., I, p. 455, 1817.

Metoporhaphis calcarata, STIMPSON, Ann. Lyc. Nat. Hist. N. Y., VII, p. 198, 1860.—SMITH, Rept. U. S. Commr. of Fish and Fisheries for 1885 (1887), p. 620 (*Metoporhapis calcaratus*).—A. MILNE-EDWARDS, *op. cit.*, p. 174, 1878 (*calcaratus*).—MIERS, Challenger Rept., XVII, p. 4, 1886 (*Metoporaphis*).

The specimens of *Metoporhaphis* examined represent eleven localities and agree in the characters given below.

Besides the four gastric tubercles and the large tubercle on the cardiac region, there is a postorbital tubercle remote from the orbit and slightly in advance of the gastric tubercles; two hepatic tubercles, one of which is marginal; three branchial tubercles, one marginal and the other two nearly longitudinal; a subbranchial tubercle in advance of the marginal tubercle; the pterygostomian ridge is provided with a

tubercle, and there is a granule in front of the angle of the buccal cavity. The rostrum bears four or five slender spines, which project outwardly in an alternate series from the opposite sides of the lower surface; they are not always apparent in small specimens; two of these spines are near together close to the extremity, and sometimes give the rostrum the appearance of being trifid at the extremity. The basal antennal joint has a spine below midway of its length and another at its outer distal angle. The two last segments of the abdomen in the male are coalesced; on the sternum, in front of the abdomen, are two or three spines on either side, which form converging lines parallel to the terminal segment of the abdomen. The second, third, and fourth segments in the female abdomen are very short and about equal in length; the last three segments are coalesced. The merus of the maxilliped is longer and less deeply cut than in A. Milne-Edwards's figure of *M. forficulatus;* the first joint of the palpus is also much longer.

Chelipeds in the male stout. The ischium and merus have sharp spines on the outer margin which become obsolete near the carpus; they have small spines on the inner lower margin, and the merus has one long spine at the end of its upper surface. The carpus has a series of sharp spines on its inner and outer margins, and one near each extremity of its upper surface. The manus is broad and inflated, with long spines above, and short ones below interspersed with long hairs. Fingers about as long as the palm; the prehensile edges are furnished with truncate denticulate teeth except at the extremities, where they become closely fitting triangular teeth. The chelipeds of the female are much feebler, the fingers much longer and more gaping, with sharp spines on the prehensile edges.

Measurements (of adult male):—Length of carapace and rostrum, 19.5 mm.; length of rostrum, 11; width, 8.2; length of cheliped about 21.5.

Localities.

Off Cape Hatteras, N. C., lat. 35° 08′ 30″ N., long. 75° 10′ W., 49 fathoms, gray sand, station 2596; U. S. Fish Commission steamer *Albatross*, 1885; 1 female with eggs (18068).

Off Cape Fear, N. C., lat. 33° 37′ 30″ N., long. 77° 36′ 30″ W., 14 fathoms, coarse yellow sand, broken shells, station 2617; 1 male (18069).

Middle Sound, near Wilmington, N. C.; U. S. Fish Commission, R. E. Earll, April 18, 1880; 1 male (4384).

Key West, Fla.; U. S. Fish Commission steamer *Albatross*, Mar. 27, 1886; 1 male (11385).

Marco, Fla.; U. S. Fish Commission schooner *Grampus*, Feb. 25, 1889; 1 female with eggs (15323); H. Hemphill, 1885; 1 female with eggs (18070).

Charlotte Harbor, Fla.; Union College collection (767) 1 female.

Sarasota Bay, Fla.; Union College collection (687) 4 males, 3 females.

West Florida; Henderson and Simpson; 1 male, 2 females, 2 young (18071).

Off Mobile Bay, Ala., lat. 29° 24′ 30″ N., long. 88° 01′ W., 35 fathoms, yellow sand, black specks, station 2388; U. S. Fish Commission steamer *Albatross*, 1885; 1 male (9695).

ACHÆUS TUBERCULATUS, Miers.

Achæus tuberculatus, MIERS, Proc. Zool. Soc. London, p. 25, 1879.—ORTMANN, Zool. Jahrb., VII, 1, p. 34, 1893.

To this species I have referred a single, imperfect, dried specimen (No. 18072) from Japan, collected by the Rev. H. Loomis. The cardiac and gastric tubercles are granulate at the summit; there is a small low tubercle on the branchial region near the inner angle, and another near the posterior margin. The hepatic region is swollen; its projection is broad, granulate on the margin, and somewhat bilobate; from it a granulate ridge runs diagonally to the posterior extremity of the superior orbital border. The inferior surface of the carapace bears several tubercles and granules near the margin. The rostral teeth are granulate and curved inwards, so that the interspace is almost oval; rostral grooves deep. Second joint of antenna not quite equaling the rostrum. Eye-stalks stout, bearing a small tubercle above near the extremity. Abdomen of male very broad; terminal segment narrowing toward the proximal end, distal angle bearing a smooth prominence; distal margin arcuate in its middle half.

Chelipeds very large. Merus much larger than the palm, spinulous on the margins and with a large lobe at the distal end of the outer surface. Carpus spinulous on inner margin, a few tubercles on proximal half of outer surface, and a tuberculous lobe at the articulation with the manus. Manus inflated, spinulous above; palmar portion exceeding the pollex but little; digits with a longitudinal sulcus on the outer surface, prehensile edges toothed and fitting together. The ambulatory legs are for the most part missing. The dactyl of the last pair is long and slightly curved.

Measurements.—Length of carapace, 13 mm.; width, 10.5; length of dactyl of fourth ambulatory leg, 6.

This individual corresponds to Miers's brief description taken from imperfect specimens, excepting that he defines the eye-peduncles as smooth. In the specimen at hand, the tubercle at the tip is so inconspicuous that it might have been overlooked.

ACHÆUS TRITUBERCULATUS, new species.

Carapace narrower than in *A. japonicus*, not constricted behind the orbital area; regions well marked but not protuberant; gastric and branchial regions smooth; cardiac region with three low tubercles, the posterior one on the median line; hepatic region with a broad obtuse prominence. Rostral lobes spinulous on the margin, separated by a V-shaped sinus which is narrower than either lobe. Rostral grooves deep. Eye-peduncle with a sharp-pointed tubercle on the upper side near the cornea. The peduncle widens toward the cornea, which is very oblique, directed downward and inward. Second joint of the antenna equaling the rostrum. The abdomen of the male is narrower than in the specimen I have named *A. tuberculatus*, and does not widen at the

terminal segment as in that species. The cheliped is of moderate size, spinulous. The palm is mutilated. The fingers have thin outer margins, concave surfaces, and denticulate inner edges. The first pair of ambulatory legs is nearly four times the length of the carapace, the second pair but little shorter than the first, third and fourth pairs nearly equal in length, the last pair a little more than twice as long as the carapace. The dactyli of the last two pairs are falciform.

Measurements.—Length, 10.5; width, 7.5 mm.

Locality.—Kanada Bay, Japan; dredged in 10 fathoms, mud; 1 male (14463).

This species approaches *A. lacertosus*, Stimpson, in having no spines on the carapace and in the form of the ambulatory legs, but that species is narrower, without tubercles on the gastric region, or a tubercle on the eye.

PODOCHELA RIISEI, Stimpson.

Podochela riisei, STIMPSON, Ann. Lyc. Nat. Hist. N. Y., VII, p. 196, pl. II, fig. 6, 1860.—A. MILNE-EDWARDS, Crust. du Mexique, p. 193, pl. XXXV, fig. 1, 1879 (*reisei*).—MIERS, *Challenger* Rept., Zool., XVII, p. 11, 1886.

Podonema riisei, STIMPSON, Bull. Mus. Comp. Zool., II, p. 126, 1870.—MIERS, Jour. Linn. Soc. London, XIV, p. 643, 1879.

Coryrhynchus riisei, KINGSLEY, Amer. Nat., XIII, p. 585, 1879; Proc. Acad. Nat. Sci. Phila., XXXI, p. 384, 1879.

The basal antennal joint is much more dilated at the postero-external angle than is represented in A. Milne-Edwards's figure.

Measurements.—Length (of male), 14.6 mm.; width, 11.2. Length (of female), 17.8; width, 13.8.

Localities.

Pensacola, Fla., 3 to 4 fathoms; James E. Benedict, July, 1893.

Gulf of Mexico and Caribbean Sea at the following stations of the steamer *Albatross:*

Cat. No.	Station.	Lat. N.			Long. W.			Fathoms.	Nature of bottom.	Date.
		°	′	″	°	′	″			1885.
18147	2363	22	07	30	87	06	00	21	wh. R. Co.	Jan. 30
15163	2390	29	27	30	87	48	30	30	crs. S. bk. Sp. Sh.	Mar. 4
18073	2405	28	45	00	85	02	00	30	gy. S. brk. Co.	15
9794	2406	28	46	00	84	49	00	26	crs. S. Co.	15

On account of the diversity of form presented by the rostra of the various species of this genus, it seems best not to retain the name *Coryrhynchus* as a subgeneric designation.

PODOCHELA SPATULIFRONS, A. Milne-Edwards.

Podochela spatulifrons, A. MILNE-EDWARDS, *op. cit.*, p. 192, pl. XXXIV, fig. 2, 1879.

The upper surface of the carapace resembles that of *P. riisei;* the prominences are tuberculiform and not spiniform, as in adult specimens of *P. riisei.* The basal antennal joint is rectangular at its anterior extremity and is of nearly equal width throughout its length, while in *P. riisei* it is narrowed and rounded anteriorly and expanded at the

postero-lateral margin. A tubercle in *P. spatulifrons* takes the place of the pterygostomian ridge in *P. riisei.* In the male the manus is swollen, and the fingers are slightly gaping. The sternum and abdomen are much like those of *P. riisei.*

Measurements.—Length (of male), 13 mm.; width, 9. Length (of female), 20; width, 16.

Localities.

Harbor Key, Florida; Union College Collection (813). Labeled *P. riisei.*
Marco; H. Hemphill, (15161).
Sarasota Bay, Florida; Union College Collection (646, 708). Labeled *P. riisei.*

PODOCHELA HYPOGLYPHA, (Stimpson).

Podonema hypoglypha, STIMPSON, Bull. Mus. Comp. Zool, II, p. 127, 1870.
Podochela hypoglypha, A. MILNE EDWARDS, *op. cit.*, p. 194, 1879.

Measurements.—Length (of male), 20; width, 14 mm.

Localities.

Key West, Florida; D. S. Jordan, Dec., 1883 (15162).
Cedar Keys, Florida; Lieut. J. F. Moser, U. S. N., U. S. Coast Survey steamer *Bache*, Feb. 1887 (18074).
West Coast of Florida; Henderson and Simpson (18075).

PODOCHELA LAMELLIGERA, (Stimpson).

Podonema lamelligera, STIMPSON, Bull. Mus. Comp. Zool., II, p. 126, 1870.
Podochela lamelligera, A. MILNE-EDWARDS, *op. cit.*, p. 193, 1879.

This species is readily distinguished from the foregoing. The rostrum is narrower and pointed, though hollow underneath. The basal antennal joint has a small acute tooth projecting forward from its antero-external angle; the laminiform margins are very prominent, especially the inner one, which is deepest at about the middle of its length, at which point there is a transverse crest on the joint. The partition between the antennular fossæ is prolonged downward at the middle in a sharp tooth. The two small tubercles present in the preceding species at the extremity of the epistome are in *P. lamelligera* much enlarged, forming large triangular laminiform projections, the anterior one not far behind the orbit, the posterior one lower down. The hepatic projection forms a slender spine. The angle of the buccal cavity is cristate and the pterygostomian crest bears a large tooth in the middle of its length. At the base of each cheliped there are two thin plates projecting downward and inward, and two on the sternum at the extremity of the male abdomen. The sternal plates are broad, thin, bearing spinules, their posterior margins turned downward and overlapping the next plate. The coxal joint of each ambulatory leg is furnished on the lower side with a cup-shaped expansion.

Measurements.—Length (of male), 18 mm.; width, 12.5; length of cheliped, about 18. Length (of female), 20; width, 16; length of cheliped, 23; length of first ambulatory leg, 60; length of merus, 20;

carpus, 7; propodus, 25; dactylus, 6; length of second ambulatory leg, 42; length of merus, 17; carpus, 7; propodus, 13; dactylus, 3.5; length of third ambulatory leg, 35; length of merus, 13.2; carpus, 6.5; propodus, 10; dactylus, 3; length of fourth ambulatory leg, 32; length of merus, 11.3; carpus, 6; propodus, 9; dactylus, 2.7.

This species was collected in the Gulf of Mexico and Straits of Florida by the steamer *Albatross*, 1885, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.
		° ′ ″	° ′ ″		
18076	2317	24 25 45	81 46 45	45	Co.
18077	2405	28 45 00	85 02 00	30	gy. S. brk. Co.

PODOCHELA MACRODERA, Stimpson.

Podochela macrodera, STIMPSON, Ann. Lyc. Nat. Hist. N. Y., VII, p. 196, 1860.—A. MILNE-EDWARDS, *op. cit.*, p. 191, pl. XXXIV, fig. 3, 1879.

In this species the rostrum is thick, obtuse, short, and not hollow beneath. There is a white tubercle on the median line at the end of the first abdominal segment in the male; also two on the sternum in front of the abdomen. The hands are much inflated and the fingers gaping. The basal antennal joint in these specimens is narrower distally than in A. Milne-Edwards's figure, the lateral ridges are smooth and rounded and coalesced for their anterior third. There is a small tubercle on each side of the epistome.

Measurements.—Length (of male), 15.2 mm.; width, 11.

Localities.

Key West, Florida; D. S. Jordan; 1 male (6368).

St. Thomas, West Indies; U. S. Fish Commission steamer *Albatross*, 1884; 1 male (18078)

PODOCHELA GRACILIPES, Stimpson.

Podochela gracilipes, STIMPSON, Bull. Mus. Comp. Zool., II, p. 126, 1870.—A. MILNE-EDWARDS, *op. cit.*, p. 192, pl. XXXV, fig. 1, 1879.

In the larger specimens the two small tubercles at either end of the epistome, and also the projecting angle of the buccal cavity are visible in a dorsal view.

Measurements.—Length of largest specimen, 12.5; width, 8 mm.

Localities.

Off South Carolina to the Gulf of Mexico and Caribbean Sea, U. S. Fish Commission steamer *Albatross*, 1884–1886, at the following stations:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.	Date.
		° ′ ″	° ′ ″			
7789	2142	9 30 15	76 20 30	42	gn. M. S.	Mar. 23
18079	2311	32 55 00	77 54 00	79	crs. S. bk. Sp.	Jan. 5
18080	2360	22 08 30	86 49 00	26	wh. Co.	30
18081	2363	22 07 30	87 06 00	21	wh. R. Co.	30
18082	2365	22 18 00	87 04 00	24	wh. R. Co.	30
18083	2370	29 18 15	85 32 00	25	crs. gy. S. brk. Sh.	Feb. 7
18084	2372	29 15 30	85 29 30	27	G.	7
18085	2373	29 14 00	85 29 15	25	Co.	7
18086	2388	29 24 30	88 01 00	35	yl. S. bk. Sp.	Mar. 4
18087	2390	29 27 30	87 48 30	30	crs. S. bk. Sp. Sh.	4
18088	2405	28 45 00	85 02 00	30	gy. S. brk. Co.	15
18089	2406	28 46 00	84 49 00	26	crs. S. Co.	15
18090	2407	28 47 30	84 37 00	24	Co. brk. Sh.	15
18091	2412	26 18 30	83 08 45	27	fne. gy. S. bk. Sp. brk. Sh.	19
18092	2413	26 00 00	82 57 30	24	fne. S. bk. S. brk. Sh.	19
18093	2414	25 04 30	82 59 15	26	fne. wh. S. brk. Sh.	19
11408	2639	25 04 50	80 15 10	56	Co. S.	Apr. 9

PODOCHELA SPINIFRONS, new species.

Carapace spinuliferous. Cardiac region with an erect spine; gastric region with a spine directed forward and a spiny tubercle in front of the latter. The rostrum is long and sharp, arched, with a median spiniferous crest. Orbits with an erect spinuliferous crest, bearing two slender spines. The antennal joint is largely visible from above and carries a spine at its anterior angle. There is an oblong laminiform postorbital tooth and behind and below it a flat triangular tooth; these two teeth correspond in position to the small tubercles present in *P. gracilipes* and other species. The hepatic spine is narrow, flattened and obtuse, and the pterygostomian region has a similar spine. The buccal cavity is conspicuously crested at its anterior angle. The antennal joint has a cristiform inner margin and an angular ridge on its posterior half. The sternal crests in the male are flat, tuberculous, and separated by deep sulci. The coxal joints of the legs bear crests similar to those in *P. lamelligera*, but less prominent. The anterior part of the sternum in the male is pubescent, and has two stout spines in front of the abdomen, which project downward and forward. The first segment of the abdomen bears a spiniform tubercle at its distal extremity. The chelipeds in both sexes are slender, hirsute and spinuliferous; fingers with prehensile edges in contact. Ambulatory legs very hairy, except the slender yellow horny tips of the dactyli. Propodal joints slender, dactyli slightly curved.

Measurements.—Length (of male), 22 mm.; width, 15; length of cheliped, 26; length of merus of first ambulatory leg, 25; carpus, 8.5; propodus, 34; dactylus, 11.5; length of merus of second ambulatory leg, 23; carpus, 10; propodus, 21; dactylus, 5.7; length of merus of third ambulatory leg, 20; carpus, 10.8; propodus, 15; dactylus, 4.5; length of

merus of fourth ambulatory leg, 18; carpus, 10; propodus, 13; dactylus, 4; length (of female), 24; width, 16.5. Length (of female), 21; width, 13.5; length of rostrum, 5.

Localities.

West Indies and Caribbean Sea; U. S. Fish Commission steamer *Albatross*, 1884, 1885, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.	Sex.	Date.
		° ′ ″	° ′ ″				
6945	2167	23 10 40	82 20 30	201	Co	1 ♀	May 1
9510	2337	23 10 39	82 20 21	199	Co	1 ♂	Jan. 19
18094	2354	20 59 30	86 23 45	130	Co	1 ♀	22

Subfamily INACHINÆ.

COLLODES DEPRESSUS, A. Milne-Edwards.

Collodes depressus, A. MILNE-EDWARDS, Crust. du Mexique, p. 176, pl. XXXII, fig. 4, 1878.—SMITH, Proc. U. S. Nat. Mus., VI, pp. 5, 8, 1883; Rept. U. S. Fish Commr. for 1885 (1887), p. 621.

Measurements.—Length (of largest male), 14; width, 11.5. Length (of largest female), 12; width, 9.7 mm.

Localities.

Off Cape Hatteras, N. C., to the Gulf of Mexico; U. S. Fish Commission steamer *Albatross*, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″		°F.		1885.
18095	2311	32 55 00	77 54 00	79	59.1	crs. S. bk. Sp	Jan. 3
18096	2370	29 18 15	85 32 00	25		crs. gy. S. brk. Sh	Feb. 7
18097	2372	29 15 30	85 29 30	27		G	Feb. 7
18098	2374	29 11 30	85 29 00	26		S. G. brk. Sh	Feb. 7
9783	2405	28 45 00	85 02 00	30		gy. S. brk. Co	Mar. 15
18099	2413	26 00 00	82 57 30	24		fne. S. bk. Sp. brk. Sh	Mar. 19
18100	2596	35 08 30	75 10 00	49		gy. S	Oct. 17

This species is probably identical with *C. trispinosus*, Stimpson.

COLLODES ROBUSTUS, Smith.

Collodes depressus, SMITH, Proc. U. S. Nat. Mus., III, p. 414, 1881. (Not A. MILNE-EDWARDS).

Collodes robustus, SMITH, *op. cit.*, VI, p. 5, 1883.

Localities.

Off Chesapeake Bay at the following stations of the U. S. Fish Commission steamer *Albatross*:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″		°F.		1885.
9868	2420	37 03 20	74 31 40	104	47.7°	bk. S. M. G	April 5
10085	2421	37 07 00	74 34 30	64		fne. gy. S. P	June 3
15152	2422	37 08 30	74 33 30	85	52.5	crs. gy. S. bk. Sp. brk. Sh	June 3

COLLODES LEPTOCHELES, new species.

Collodes robustus, Smith, of the Atlantic coast of North America, is replaced in the Gulf of Mexico by a closely allied species. The carapace is similar in shape to that of *C. robustus*. Surface tuberculous, without spines. Rostrum divided by a V-shaped notch into two acute teeth shorter than in *C. robustus*, their outer margin convex. Postorbital tooth broad and long, much exceeding the eyes. The abdomen of the male is broader than in *C. robustus*, constricted at the fifth segment; a small spine or tubercle on the first segment, and a long spine on the fifth directed downward and backward. The appendages of the first segment are more divergent than in *C. robustus*, and more slender at the tips. There is a small spine on the fifth segment in the female. The chelipeds are weak in both sexes, about as long as the carapace; manus slender, fingers as long as the palm. Ambulatory legs stouter than in *C. robustus*, the first and second pairs nearly equal in length, the second often exceeding the first, about twice as long as the carapace; dactylus of last two pairs longer than the propodus. The color in alcohol is a pale écru, while *C. robustus* is yellowish.

Measurements.—Length of carapace (of male), 16.5 mm; width, 12.7; length of cheliped, 17; length of first ambulatory leg, 34.7; second, 35; third, 31.5; fourth, 30.7; length of propodus of third ambulatory leg, 6.5; dactylus, 7.2; length of propodus of fourth ambulatory leg, 6.7; dactylus, 7.7. Length of carapace (of female), 17.5; width, 13.2; length of cheliped, 17; length of first ambulatory leg, 31.5; second, 35; third, 32.5; fourth, 30.

Localities.

Five stations in the Gulf of Mexico, as follows:

Cat. No.	Station.	Lat. N.			Long. W.			Fathoms.	Nature of bottom.	Date.
		°	′	″	°	′	″			1885.
18101	2378	29	14	30	88	09	30	68	gy. M	Feb. 11
9748	2400	28	41	00	86	07	00	169	gy. M	Mar. 14
9751	2401	28	38	30	85	52	30	142	gn. M. brk. St	Mar. 14
18102	2402	28	36	00	85	33	30	111	gy. M	Mar. 14
18103	2403	28	42	30	85	29	00	88	gy. M	Mar. 15

COLLODES, doubtful species.

Four small dried specimens frum the Gulf of California are intermediate between *C. tenuirostris* and *C. granosus*. They have a rostrum intermdiate in length between the two, not fissured, but minutely bifid at the tip. There are two cylindrical spines on the gastric and cardiac regions, and a smaller more acute spine on the first abdominal segment. There are a few granules on the branchial and hepatic regions. The eyes are large, exceeding the postocular tooth. The carapace is proportionally wider at the hepatic regions than in *C. tenuirostris*.

Measurements.—Length (of male), 6.5; width at branchial regions, 4.5; width at hepatic regions, 3.6 mm.

Locality.—Lat. 29° 30′ N., long. 112° 40′ W., 45 fathoms; Lieut. Comdr. H. E. Nichols, U. S. N.; 2 males, 2 immature females (18104).

BATRACHONOTUS FRAGOSUS, Stimpson.

Batrachonotus fragosus, STIMPSON, Bull. Mus. Comp. Zool., II, p. 122, 1870.—A. MILNE-EDWARDS, *op. cit.*, p. 180, 1879.

Stimpson's description was made from a single specimen. The basal joint proves to have a terminal spine. The four protuberances of the carapace and also the first abdominal segment are each terminated by a spine in the males, and there are two large tubercles just above the posterior margin. In the females, of which there are two of smaller size than the males, but bearing eggs, the cardiac prominence is conspicuously rounded, granulous, without a spine; the first ambulatory leg is but very little longer than the second and about one and a half times the length of the carapace, while in the male it is more than twice as long as the carapace.

Measurements.—Length (of male), 7.8; width, 7. Length (of female), 5.3; width, 4.2 mm.

This species was collected by the *Albatross* at two stations in the Gulf of Mexico, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.	Date.
		° ′ ″	° ′ ″			1885.
18105	2370	29 18 15	85 32 00	25	crs. gy. S. brk. Sh..	Feb. 7
18106	2405	28 45 00	85 02 00	30	gy. S. brk. Co......	Mar. 15

BATRACHONOTUS BRASILIENSIS, new species.

This species is unfortunately represented by a single female specimen with only three ambulatory legs present and those detached. The specimen resembles much the female of *B. fragosus;* the depressions of the carapace are more shallow; the raised portions are covered with granules, but are without spines. The postocular spine is very small, as in *B. fragosus*, and the hepatic region projects well beyond it, and has an acute marginal tubercle. The rostral teeth are short and rounded, not extending beyond the antennular fossæ, and separated by a rounded sinus as wide as each lobe. The inferior surface of the carapace and the abdomen are set with tubercles. The three ambulatory legs are very nearly the same length, less than one and a half times the length of the carapace; dactyli long and slender, as in the preceding species.

Measurements.—Length, 7 mm.; width, 6.

Locality.—Dredged off Rio Janeiro by Mr. Richard Rathbun during the Hartt explorations in 1875–'77; 1 female with eggs.

BATRACHONOTUS NICHOLSI, new species.

Female: Regions of carapace deeply marked, elevated portions with coarse tubercles unequal in size; a tubercle on the summit of each branchial region is larger than all others, resembling a short, stout spine. The depressions of the carapace are smooth. The short rostral teeth are slightly longer than in the preceding species and the interspace equals the tooth in width. Postorbital tooth shorter than the ocular peduncle, as in the genus. Hepatic region advanced, subrectangular, the anterior margin almost at right angles to the median line. On the margin there is a tubercle at the hepatic angle, one on the pterygostomian region and two or three on the branchial region. Ridges of the basal antennal segment tuberculous, the terminal spine blunt, curved, and more produced than in other species, in this respect approaching the genus *Euprognatha*. Inferior surface tuberculous. Chelipeds tuberculous, the tubercles becoming spiniform on the inner margin of the merus. The first ambulatory leg (the only one attached) is a little more than one and a half times the length of the carapace; the dactylus is long, nearly equaling the propodus.

Measurements.—Length, 5.3 mm.; width, 4.4.

This species is represented by two small dried specimens, females, from the Gulf of California, lat. 29° 30′ N., long. 112° 40′ W., 45 fathoms, collected by Lieut. Commander H. E. Nichols, U. S. Navy. (18107).

EUPROGNATHA RASTELLIFERA, Stimpson.

Euprognatha rastellifera, STIMPSON, Bull. Mus. Comp. Zool., II, p. 123, 1870.—A. MILNE-EDWARDS, *op. cit.*, p. 183, pl. XXXIII, fig. 2, 1879.—SMITH, Proc. U. S. Nat. Mus., III, p. 415, 1881, and VI, p. 9, 1883; Rept. U. S. Fish Comr. for 1882, p. 347, pl. I, figs. 3, 3a, 1884; *op. cit.* for 1885, p. 621, 1887.

Collected by the *Albatross* at the following stations not before recorded:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
					°F.		1884.
7794	2152	2½ miles NW. of Havana Light.		387	49	Co	Apr. 30
							1885.
15153	2420	37° 03′ 20″	74° 31′ 40″	104	47.7	bk. S. M. G	Apr. 5
15154	2421	37 07 00	74 34 30	64		fne. gy. S P	June 3
10092	2422	37 08 30	74 33 30	85	52.5	crs. gy. S. bk. Sp. brk. Sh	June 3
15155	2423	37 10 15	74 32 00	143		gn. M. fne. S	June 3
							1886.
18110	2642	25 20 30	79 58 00	217	42.6	gy. S	Apr. 9

EUPROGNATHA RASTELLIFERA SPINOSA, new subspecies.

(See SMITH, Proc. U. S. Nat. Mus., VI, p. 11, 1883.)

Southern specimens of *E. rastellifera* are characterized by longer and more slender spines, noticeably the orbital spines, by the sharper and more prominent tubercles of the carapace, and by the unequal slender spines of the merus and carpus of the chelipeds. The spine on the eye is larger and more prominent than in typical *E. rastellifera*, and the

frontal region is more constricted behind the supraorbital spine. The meral joints of the ambulatory legs bear small spines.

Specimens from several stations off Havana agree in the above variations; also a small specimen from station 2313, off South Carolina. On the other hand, a male from station 2642, off Carysfort Reef, is typical in form, the dorsal prominences being reduced to tubercles. In a specimen from station 2152, 2½ miles northwest of Havana Light, the orbital spines are broad and triangular, as in typical *E. rastellifera*, but the remaining spines are long and slender, and the legs are spinous.

Measurements.—Length (of male), 9 mm.; width, 6.8; length of cheliped, about 14.5; of first ambulatory leg about 22. Length (of second male), 9.7; width, 7.6; length of cheliped about 16.2; length of second ambulatory leg about 19; third, 17; fourth, 15.

Localities.

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials	
		° ′ ″	° ′ ″		°F.		1884.
7784	2164	23 10 39	82 20 29	192	....	Co	May 1
							1885.
9441	2313	32 53 00	77 53 00	99	57.2	crs. S. bk. Sp. brk. Sh	Jan. 5
18108	2342	23 10 39	82 20 21	201	....	Co	Jan. 19
18109	2345	23 10 40	82 20 15	184	....	fne. gy. wh. Co	Jan. 20
9884	2346	23 10 39	82 20 21	200	....	Co	Jan. 20
9528	2347	23 10 39	82 20 21	216	....	Co	Jan. 20
9529	2348	23 10 39	82 20 21	211	....	Co	Jan. 20
9531	2349	23 10 40	82 20 15	182	....	Co	Jan. 20

EUPROGNATHA GRACILIPES, A. Milne-Edwards.

Euprognatha gracilipes, A. MILNE-EDWARDS, *op. cit.*, p. 184, pl. XXXV, fig. 3, 1879.

This species has a deep median furrow on the rostrum. The præorbital teeth are directed upward and forward and are separated by deep grooves from the rostrum. The hepatic spine is larger and much more produced than the postorbital spine. The median and branchial spines are cylindrical and more prominent than in *E. rastellifera*. There are five tubercles in a transverse line on the gastric region, the outer and middle ones being most prominent. There are a spine and several tubercles on the margin of the branchial region; there is also a short pterygostomian spine, the tip of which is visible from above behind the hepatic spine.

Measurements.—Length (of male), 8 mm.; width, 6.2; length of cheliped, 10.2; length of first ambulatory leg, about 24; second 17; fourth, 12.

Localities.

Off Havana, Cuba; U. S. Fish Commission steamer *Albatross* at the following stations:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.	Date.
		° ′ ″	° ′ ″			1885.
9483	2320	23 10 39	82 18 48	130	fne. Co	Jan. 17
18111	2322	23 10 54	82 17 45	115	Co	Jan. 17
9504	2331	23 10 31	82 19 55	114	Co	Jan. 17
9509	2336	23 10 48	82 18 52	157	Co	Jan. 19
18112	2342	23 10 39	82 20 21	201	Co	Jan. 19

ARACHNOPSIS FILIPES, Stimpson.

Arachnopsis filipes, STIMPSON, Bull. Mus. Comp. Zool., II, p. 121, 1870.—A. MILNE-EDWARDS, *op. cit.*, p. 181, pl. XXXIII, fig. 1, 1879.

Localities.

Straits of Florida and Gulf of Mexico; U. S. Fish Commission steamer *Albatross*, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″				1885.
18113	2315	24 26 00	81 48 15	37	....	Co	Jan. 15
18114	2317	24 25 45	81 46 45	45	75	Co	Jan. 15
18115	2318	24 25 45	81 46 00	45	75	Co	Jan. 15
18116	2370	29 18 15	85 32 00	25	....	crs. gy. S. brk. Sh	Feb. 7
18117	2405	28 45 00	85 02 00	30	....	gy. S. brk. Co	Mar. 15

APOCREMNUS SEPTEMSPINOSUS, A. Milne-Edwards.

Apocremnus septemspinosus, A. MILNE-EDWARDS, *op. cit.*, p. 185, pl. XXXV, fig. 5, 1879.

In the female the fingers are in contact throughout their length. The abdomen has a prominent median carina; the lateral portion is irregularly dotted with round pits, some of which touch each other; the terminal portion is tuberculous.

Localities.

Gulf of Mexico; U. S. Fish Commission steamer *Albatross*, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of bottom.	Date.
		° ′ ″	° ′ ″			1885.
15165	2372	29 15 30	85 29 30	27	G	Feb. 7
15164	2373	29 14 00	85 29 15	25	Co	Feb. 7
18118	2405	28 45 00	85 02 00	30	gy. S. brk. Co	Mar. 15

INACHOIDES INTERMEDIUS, new species.

Carapace entirely smooth above, punctate, regions well marked, cardiac, branchial, and gastric regions protuberant. Rostrum tipped with a spine, somewhat longer than in *I. obtusus;* base triangular, thick, with two ridges from which the sides are inclined downward, much as in *I. obtusus.* The postorbital tooth is very small. There is a tubercle on the margin of the hepatic region, and one also on the pterygostomian and the subbranchial region. Surface of abdomen of female smooth, punctate, with a median carina. Basal antennal joint unarmed except for a blunt tooth at the antero-external angle. Merus of maxillipeds deeply notched at the inner angle; inner lobe triangular, obtuse. Chelipeds in the female a little longer than the carapace. Merus somewhat angled, with a shallow tooth below near the carpal end. Manus swollen, unarmed. Fingers as long as palm, widely gaping. The first ambulatory leg is missing; the remaining legs decrease regularly in length; dactyli almost straight.

Measurements.—Length of carapace, 5.8 mm.; width, 4.2; approximate length of cheliped, 6.5; of second ambulatory, 10.7; third, 9.5; fourth 8.

Locality.—Dredged off Rio Janeiro by Mr. Richard Rathbun in the Hartt explorations of 1875–'77.

This species resembles *I. obtusus* and *I. lævis* in its thick rostrum, but it differs from all described species in its smooth dorsal surface, even the cardiac region being without a tubercle.

ANASIMUS LATUS, new species.

Carapace almost as broad as long, elevated on the median line, the posterior half semicircular in outline, the anterior half broadly triangular. Surface covered with tubercles unequal in size. There are five median spines; two gastric, the posterior the larger, one large on the cardiac region, one very small and pointing backward on the intestinal region, and one long acuminate spine directed backward at the distal end of the first abdominal segment. The anterior gastric median spine is one of a transverse row of five. In front of the extreme spines of this row are two longer and sharper. On the branchial region there are three small spines forming a triangle. There are three antero-lateral spines, one on the hepatic region and two on the branchial region above the base of the cheliped. The rostrum is short, sharp, triangular, and upturned. The supraorbital spines are prominent, separated by a deep depression. The postorbital spines are long, exceeding the eye in large specimens, much less conspicuous in small specimens. The basal antennal segment is long and narrow, terminating in a spine, and with a stout spine in front of the eye pointing downward and forward. The flagellum is short, its second joint not attaining the end of the rostrum. The pterygostomian region has a row of spines and spinules which is continued to the antennal segment and includes a long spine at the angle of the buccal cavity. The merus of the maxillipeds is strongly cordiform as in *A. fugax*. Sternum and abdomen tuberculous. Abdomen of female with median tubercles on the third and fourth segments.

The chelipeds in the male are a little more than twice the length of the carapace; ischium, merus, and carpus tuberculous; merus cylindrical; propodus swollen, palm shorter than the pollex, with fine scattered tubercles. Digits slender, curved inward, gaping at base only, their fine regular teeth in contact. In the female the chelipeds are a little longer than the carapace, are much smaller than in the male, and the fingers touch throughout their length. Ambulatory legs all very long, slender, cylindrical, armed except the dactyli with numerous small appressed spines; propodi and dactyli with a double fringe of hair.

Young individuals are narrower, with proportionally longer dorsal spines and rostrum and shorter postorbital spines.

Measurements.—Length (of large male), 25.5 mm.; breadth, 24; length of cheliped, 58; length of first ambulatory leg, 106; length (of young male), 11; breadth, 8.

Localities.

Off South Carolina to the Gulf of Mexico and Caribbean Sea, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″		° F.		1884.
6904	2121	10 37 40	61 42 40	31	67	dk. slate-col. M	Feb. 3
	2122	10 37 00	61 44 22	34	73	dk. slate-col. M	Feb. 3
							1885.
9437	2312	32 54 00	77 53 30	88	57.8	crs. S. bk. Sp.	Jan. 5
18120	2317	21 25 45	81 46 45	45	77	Co.	Jan. 15
18121	2318	24 25 45	81 46 00	45	75	Co.	Jan. 15
9656	2378	29 14 30	88 09 30	68	....	gy. M	Feb. 11
18122	2388	29 24 30	88 01 00	35	....	yl S. bk. Sp.	Mar. 4
18123	2404	28 44 00	85 16 00	60	....	gy. S	Mar. 15
18124	2405	28 45 00	85 02 00	30	....	gy. S. brk. Co	Mar. 15
18125	2406	28 46 00	84 49 00	26	....	crs. S. Co	Mar. 15

This species can be distinguished from *A. fugax* by its greater breadth of carapace, shorter rostrum and epistome, and different arrangement of spines.

EURYPODIUS LATREILLEI, Guérin.

Eurypodius latreillei, GUÉRIN, (Mém. du Muséum, XVI, p. 354, pl. XIV, 1828); Icon. Crust. R. A., ii, pl. XI, fig. 1, 1829–44.—MIERS, Proc. Zool. Soc. London, 1881, p. 64, and synonymy.

Locality.—Laredo Bay, Straits of Magellan, January 22, 1888; U. S. Fish Commission steamer *Albatross*.

OREGONIA GRACILIS, Dana.

Oregonia gracilis, DANA, Crust. U. S. Expl. Exped., I, p. 106, pl. III, fig. 2, 1852.
Oregonia hirta, DANA, *op. cit.*, p. 107, pl. III, fig. 3.
Oregonia longimana, BATE, in Lord's Nat. in Brit. Col., II, p. 267, 1866.

This species is one of the most abundant of the North Pacific brachyurans. It was collected by the *Albatross* at 84 stations, from Bristol Bay, Bering Sea, to Oregon, and in depths ranging from 5 to 135 fathoms; and by Mr. William H. Dall and others as follows:

Localities.

Alaska; Dall collection:

Cat. No.	Locality.	Fathoms.	Nature of bottom.
14705	Anchorage, Cape Etolin, Nunivak Island	8	St.
14707	Kyska Harbor	7-14	M. S.
14710	Bay of Islands, Adakh	9-16	M. S.
14770	Nazan Bay, Atka	10-16	S.
12540	Off Imagna Pinnacle, Captain's Bay, Unalaska	8-20	
•12496	Belkoffsky Bay	15-25	Sh. G.
14713	Port Levasheff		
14703	Off Round Island, Coal Harbor, Unga	8-9	S. St.
14769	Popoff Strait		
•14702	Sanborn Harbor, Nagai	low water.	
14709	Anchorage, Big Koniushi Island, Shumagins.	6-20	S. R.
14708	Port Möller	15	S.
13132	Semidi Islands	12-28	G.
14706	Chajafka Cove, Kadiak	12-14	M. S.
12501	Chajafka Cove, Kadiak	15-20	G.
12495	Chiniak Bay, Kadiak		
14711	Kachekmak Bay, Cook's Inlet	20-60	sdy. M.
14704	Port Etches	5-18	
14768	West side of Middleton Island	10-12	G. S.
14712	Lituya Bay	6-9	
12517	Granite Cove, Port Althorp		
14771	Sitka Harbor	15	G. M.
14714	Sitka		

Bering Island; L. Stejneger; young specimens (13510); N. Grebnitski (14716).

Menzies Bay, Discovery Passage, B. C., 6 fathoms, soft bottom; Lieut. Comdr. H. E. Nichols, U. S. N., U. S. C. S. S. *Hassler* (5778).

Port Orchard, Puget Sound; O. B. Johnson (14971).

ANAMATHIA CRASSA, (A. Milne-Edwards).

Plate I, fig. 4.

Amathia crassa, A. MILNE-EDWARDS, *op. cit.*, p. 203, Pl. XXVIII, fig. 2, 1879.

Amathia agassizii, SMITH, Bull. Mus. Comp. Zool., X, p. 1, pl. II, figs. 2, 3, 1882; Proc. U. S. Nat. Mus., VI, p. 3, 1883; Rept. U. S. Fish Commissioner for 1882, p. 346, 1884.

Anamathia agassizii, SMITH, Proc. U. S. Nat. Mus., VII, p. 493, 1885; Rept. U. S. Fish Commissioner for 1885, p. 624, 1887.

Several large specimens were dredged at station 2665. A female gives the following measurements in millimeters: Length of carapace, including rostral spines, 77; length of carapace, excluding rostral spines, 70; width, including spines, 59; width, excluding spines, 57; length of cheliped, 107; length of first ambulatory leg, 199; second, 164; third, 140; fourth, 132.

Localities.

Off the coast of South Carolina and Florida by the U. S. Fish Commission steamer *Albatross* as follows:

Cat. No.	Station.	Lat. N.	Long W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″		°F.		1885.
11213	2624	32 36 00	77 29 15	258		gy. S. bk. Sp.	Oct. 21
							1886.
11392	2642	25 20 30	79 58 00	217	42·6	gy. S	Apr. 9
11358	2665	29 47 00	80 05 45	263	45·2	fne. gy. S	May 4
11383	2666	30 47 30	79 49 00	270	48·3	gy. S	May 5
11397	2667	30 53 00	79 42 30	273	48·7	gy. S. bk. Sp	May 5

ANAMATHIA HYSTRIX, (Stimpson).

Amathia hystrix, STIMPSON, Bull. Mus. Comp. Zool., II, p. 124, 1870.—A. MILNE-EDWARDS, *op. cit.*, pp. 134, 200, pl. XXVIII, fig. 1, 1879; Bull. Mus. Comp. Zool., VIII, p. 2, 1880.

Anamathia hystrix, SMITH, Rept. U. S. Fish Commr. for 1885, p. 626 (1887).

Briefly characterized by Stimpson as bearing a close resemblance to *A. rissoana*, but differing in having four instead of three spines on the gastric region. The specimen at hand is the same species as that figured by A. Milne-Edwards, but differs in having much longer spines and in the greater divergence of the rostral horns.

Locality.—Two and a half miles northwest of Havana light, 387 fathoms, coral, temperature 49°, April 30, 1884, station 2152, steamer *Albatross;* one immature female (6940).

Measurements.—Length, measured from between rostral horns, 16 mm.; length of horns, 17.5; width without spines, 12; width with spines, 27; distance between tips of horns, 13.

ANAMATHIA UMBONATA, (Stimpson).

Plate I, Figs. 1–3.

Scyra umbonata, STIMPSON, Bull. Mus. Comp. Zool., II, p. 115, 1870.—A. MILNE-EDWARDS, Crust. du Mexique, p. 87, 1875, pl. XXXI A, fig. 5, 1880; Bull. Mus. Comp. Zool., VIII, p. 2, 1880.

Scyramathia umbonata, A. MILNE-EDWARDS, Comptes Rendus, XCI, p. 356, 1880. (See SARS, Den Norske Nordhavs-Expedition, XIV, Crustacea, I, p. 7, 1885; also SMITH, Rept. U. S. Fish Commr. for 1885, p. 625, 1887).

At Station 2415, off Georgia, were found four specimens of Stimpson's *Scyra umbonata*. The protuberances of the carapace are as described by him. The rostrum is composed of two slender divergent horns. The basal antennal joint is concave beneath, rather narrow and unarmed, except for the blunt tooth at the antero-external angle. The surface is covered with a dense coat of broad setæ similar to those described by Sars as occurring on *Scyramathia carpenteri*. The legs are bordered by longer club-shaped setæ, while the gastric region and the margins of the rostrum and branchial regions are furnished with long slender hairs curved at the tips. There is a prominent præorbital spine and a post-orbital lobe.

The four specimens in the haul are alike in all essential particulars. Three are females, two of them bearing eggs, and the fourth is a small male. In the latter the rostral horns are more divergent. The largest female has a total length of 29 mm.

Three other specimens occur at station 2668, off Fernandina, Florida. The ambulatory legs of all are longer and more cylindrical than in the individuals from station 2415. One (which I will call A) is a male, 26.5 mm. long. This also is a typical *umbonata* as regards the orbits and ornamentation of the carapace, and is apparently mature, the chelipeds being elongate, about 1½ times the length of the carapace, the propodus much longer than the merus and strong, its margins thin and subparallel; fingers gaping for their basal half, dactylus with a basal tooth. Ambulatory legs with the club-shaped setæ reduced in size.

The largest specimen (C) from this station is an ovigerous female, 31 mm. long. The carapace is much swollen and smoother than in those above described. There are but three flat-topped protuberances, the cardiac and anterior branchial; their flattened tops are smaller than their bases. The other prominences are simply tubercles, the gastric one being elongate and smoothly rounded. The marginal spines are tapering, and not broad and flat as in the specimens from station 2415, the hepatic spine not erect but directed outward and slightly forward and upward, and the branchial spine directed not forward but outward and slightly upward. The ambulatory legs are conspicuously clothed with long slender bristles among the short setæ.

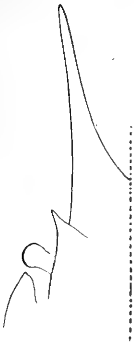
These characters are sufficient to make this specimen specifically distinct from those described above, were it not that the third specimen (B) from this dredge haul is intermediate in character. It is a male, 28 mm. long, but with the chelipeds not strongly developed. The protuberances of the dorsal surface are as in C, excepting that the flattened tops of the three prominences overhang their bases. The marginal spines are as in A. The ambulatory legs are as in C, and the carapace has more long fine bristles than in any other specimens.

In C (fig. 3) the orbits are widely open, more so than in *A. crassa* (fig. 4); there is in fact no upper surface to the orbit. The outer surface of the postorbital lobe is flat, and it is directed forward or in a line almost parallel to the median line. The præorbital spine is directed well outward; its posterior or outer margin is concave, directed strongly inward from the tip and then slightly outward. In A (fig. 1) the outer margin of the postorbital lobe is inclined strongly inward; the outer margin of the præorbital spine is directed slightly inward from the tip and is convex posteriorly. This disposition of the orbital spines necessarily makes the opening of the orbit narrower as seen from above, especially at the posterior end where the narrow sinus gives it an appearance similar to that seen in *A. carpenteri*, which Prof. Sars considered to be allied to the genus *Hyastenus* (see fig. 5, *H. longipes*). In the orbits of B (fig. 2) the intermediate character is again seen, the postorbital lobes resembling those of A, the præorbital spines those of C.

A. carpenteri (Norman) is more pyriform than *A. umbonata*, narrower anteriorly, and the præorbital spine is reduced to a lobule.

Measurements in millimeters.

Sex	♂ (A)	♀ (C)	♀
Station	2668	2668	2415
Total length of carapace	25.6	31	29
Length of rostral spine, inside measure	7.3	7	6.8
Total width of carapace	19	20	22
Width without spines	15	17.5	17.5
Length of cheliped	41.5	30	26
Length of first ambulatory leg	42	49	38
Length of second ambulatory leg	33	40	31
Length of third ambulatory leg	27.5	34	27
Length of fourth ambulatory leg	26	32	26



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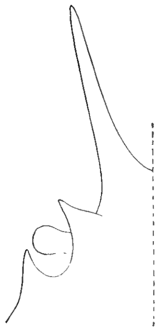

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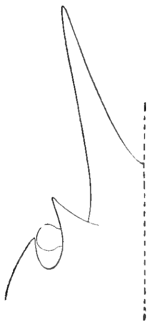

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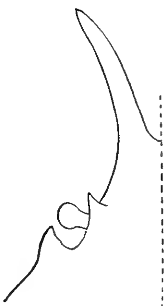

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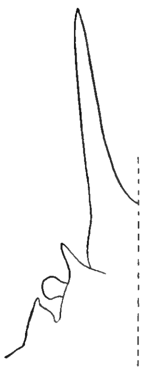


5

ORBITAL VARIATIONS OF ANAMATHIA.

FIGS. 1–3. Orbit and rostrum of *Anamathia umbonata* × 3½.
FIG. 4. Same of *Anamathia crassa* × 1⅗.
FIG. 5. Same of *Hyastenus longipes* × 1⅗.

TRACHYMAIA CORNUTA, A. Milne-Edwards.

Trachymaia cornuta, A. MILNE-EDWARDS, Crust. du Mexique, I, p. 352, pl. XXXI A, fig. 2, 1880.

The single specimen collected by the *Albatross* is larger than that figured by A. Milne-Edwards. The carapace is rough with spinules, and covered with soft bristles. The four spines on the gastric region form a transverse diamond; there are two median spines close together on the cardiac region; five spines on the branchial region, three near the inner margin and two near the outer; one hepatic and one subhepatic spine. On the posterior margin of the carapace is a line of twenty-five small spines terminating above the first ambulatory leg; of this row the median spine and two near the middle are larger than the others. On the margin of the branchial region there is a line of four spines extending forward from above the first ambulatory leg. On the pterygostomian region there is a cluster of four spines. The rostral spines are longer, more slender, and more divergent than in A. Milne-Edwards's figure. The præorbital spine is acuminate; the postorbital is long, projecting laterally much beyond the eye. The eyes are large and flattened almost in a horizontal direction. There is a large suborbital spine, and a spine at the angle of the buccal cavity. The basal antennal segment bears a terminal and one lateral spine; the second joint of the flagellum reaches half way to the end of the rostral spines, while the remaining portion of the flagellum exceeds the rostrum by half its length. In the abdomen of the male the first segment has three spinules transversely arranged; the second has two median and one lateral; the third and fourth have a median tubercle. Sternum with four spinules in front of the abdomen.

The chelipeds are nearly twice the length of the carapace; ischium, merus, and carpus spiny. Manus broad; upper margin with a small spine near the carpus and at a little distance a minute spinule visible with the glass; lower margin with a tooth near the articulation. Fingers flattened laterally, broad, toothed on the prehensile edges, acute, narrowly gaping for half their length. Ambulatory legs slender, with scattered bristles, the first nearly three times the length of carapace, the fourth about one-half the length of the first. Other legs missing.

Measurements.—Length, 18 mm.; width, without spines, 13; length of rostral horns, 3.2; length of cheliped 33.5; length of first ambulatory leg, 52; length of fourth, to articulation of dactylus, 21.

Locality.—Little Bahama Bank, lat. 27° 22′ N., long. 78° 07′ 30″ W., 338 fathoms, gray sand, temp. 47.5°, May 2, 1886, station 2655; one male (11400).

I have examined three small specimens from the *Blake* collection in the Museum of Comparative Zoölogy and find that they agree with the one above described in the very slender rostral spines and the relative length of the antennal joints, and also possess spinules on the upper margin of the manus.

LISPOGNATHUS THOMSONI, (Norman).

Dorynchus thomsoni, NORMAN, in Thomson, Depths of the Sea, p. 174, cut, 1873.
Lispognathus thomsoni, A. MILNE-EDWARDS, (Arch. Miss. Sci. Litt., IX, pp. 16, 39, 1882). MIERS, *Challenger* Rept., Zool., XVII, p. 28, Pl. V, fig. 2 (variety), 1886, and synonymy.—SMITH, Rept. U. S. Commr. of Fisheries for 1885, p. 622, 1887, and synonymy.

Locality.—Off Georgia, lat. 30° 44′ N., long. 79° 26′ W., 440 fathoms, coral, coarse sand, shells and foraminifera, temperature 45.6°, April 1, 1885, station 2415, U. S. Fish Commission steamer *Albatross;* 1 male, 1 female (18119).

These specimens have been compared with a female from station 2262, off Martha's Vineyard (Smith, *loc. cit.*). They are about the same size and apparently the same species.

HOLOPLITES, new genus.

Carapace pyriform, covered with sharp spines of unequal length. Rostrum composed of two long, slender, divergent horns. Præorbital spines long. Orbits open, spinous. Basal antennal segment very narrow, spinous. Antero-internal angle of the merus of the maxillipeds oblique, not notched for the articulation of the palpus. Abdomen of female with the fourth, fifth, and sixth segments coalesced. Chelipeds and meral joints of ambulatory legs spinous.

This genus resembles *Echinoplax*, Miers, in many respects, but does not possess accessory spinules on the rostrum. It differs from *Nibilia* in the very incomplete orbits, the narrow basal antennal segment, the number of abdominal segments in the female, as well as in the form of the maxillipeds.

HOLOPLITES ARMATUS, (A. Milne-Édwards).

Nibilia armata, A. MILNE-EDWARDS, Crust. du Mexique, p. 348, pl. XXXI A, fig. 3, 1880.

One specimen (18126), a female with eggs, from station 2152, two and a half miles northwest of Havana Light, 387 fathoms, coral, temperature 49°.

The spine above the orbit is nearer the postorbital than the præorbital, and is longer than represented in A. Milne-Edwards's figure. There is also a subhepatic spine. The rostrum of the *Albatross* specimen is longer proportionally than the one figured and is not divided to its base. The first three segments of the abdomen in the female are very narrow and have each a median spine, diminishing in length from the first to the third; the second and third segments have lateral spinules, which are almost imperceptible on the third; fourth segment very large and smooth; terminal segment broadly rounded at the extremity. The abdomen has scattered hairs like the rest of the surface.

Measurements.—Length, including rostrum, 23.5 mm.; length of rostral spines, 8; width, without spines, 11; width, including spines, 16.

CHORINUS HEROS, (Herbst).

Cancer heros, HERBST, Natur. Krabben und Krebse, II, p. 165, pl. XLII, fig. 1, pl. XVIII, fig. 102, 1796.
Chorinus heros, LEACH (Latreille, Encyc., t. 10, p. 139).—A. MILNE-EDWARDS, *op. cit.*, p. 86, and synonymy.

Localities.—San Domingo, W. M. Gabb, 1878 (4176). Rio Vermelho, Bahia, Brazil, February 6; Richard Rathbun, Hartt Explorations, 1875–'77.

TRICHOPLATUS HUTTONI, (A. Milne-Edwards).

Trichoplatus huttoni, A. MILNE-EDWARDS, (Ann. Sci. Nat. (6), IV, art. 9, pp. 1–3, pl. X, 1876), *fide* Zool. Rec., 1877.—MIERS, Jour. Linn. Soc. London, XIV, p. 647, 1879, (*Erichoplatus*).
Halimus hectori, MIERS, Ann. N. H. (4), XVII, p. 219, 1876; Cat. Crust. New Zealand, p. 4, 1876.

In a male from New Zealand, presented by the Otago University Museum (16224), the chelipeds are very robust; in another from Bluff Harbor, New Zealand (18127), the right cheliped is short and slender, the left long and robust.

Subfamily ACANTHONYCHINÆ.

ANOMALOTHIR FURCILLATUS, (Stimpson).

Anomalopus furcillatus, STIMPSON, Bull. Mus. Comp. Zool., II, p. 125, 1870.—A. MILNE-EDWARDS, Crust. du Mexique, p. 188, pl. XXXV, fig. 4, 1879.
Anomalothir furcillatus, MIERS, Jour. Linn. Soc., London, XIV, p. 648, 1879.

Localities.

Collected by the *Albatross* at the following stations:

Cat. No.	Station.	Lat. N.	Long. W.	Fathoms.	Nature of Bottom.	Date.
		° ′ ″	° ′ ″			1885.
15166	2346	23 10 39	82 20 21	200	Co.	Jan. 20
18127	2401	28 38 30	85 52 30	142	gn. M. brk. Sh	Mar. 14
18128	2601	34 39 15	75 33 30	107	gy. S.	Oct. 18
15156	2319–50	Off Havana, Cuba.		33–279	Co.	Jan. 17-20

MOCOSOA CREBRIPUNCTATA, (Stimpson).

Mocosoa crebripunctata, STIMPSON, Bull. Mus. Comp. Zool., II, p. 128, 1870.—A. MILNE-EDWARDS, *op. cit.*, p. 137, 1878.

The large immovable eyes completely fill the circular orbits which are provided with a small, inconspicuous tooth on the outer side. The area above the orbit is thickened and protuberant, but without a præocular spine. The third, fourth, and fifth segments of the abdomen in the male are coalesced. The chelipeds are stout, elongate; merus cylindrical; manus slightly compressed, widening distally; fingers very short and stout, little gaping, dentate. The surface of the crab is everywhere punctate.

Measurements.—Length, 7; width, 6.2 mm.

Locality.—Gulf of Mexico, lat. 29° 15′ 30″ N., long. 85° 29′ 30″ W., 27 fathoms, gravel, station 2372, steamer *Albatross*, Feb. 7, 1885; one male (18129).

SPHENOCARCINUS CORROSUS, A. Milne-Edwards.

Sphenocarcinus corrosus, A. MILNE-EDWARDS, *op. cit.*, p. 136, pl. XVII, fig. 5, 1878.

One female with eggs, from off Cape Fear, North Carolina, lat. 33° 20′ N., long. 77° 05′ W., 90 fathoms, gray sand, temperature 65.8°, April 2, 1885 (15183).

In this specimen the rostrum is longer than in A. Milne-Edwards's figure and the horns are divergent for their terminal half. The supraorbital margin terminates anteriorly in a rounded lobe more prominent than is indicated in the figure. The protogastric lobes are larger and more broadly joined to the mesogastric. The middle portion of the cardiac lobe is also deeper than represented in the figure.

SIMOCARCINUS SIMPLEX, (Dana).

Huenia simplex, DANA, Crust. U. S. Expl. Exped., I, p. 133, pl. 6, fig. 3, 1852, male.

Huenia brevirostrata, DANA, *op. cit.*, p. 134, pl. 6, fig. 4, female.

Simocarcinus simplex, MIERS, Ann. Mag. Nat. Hist. (5), IV, p. 6, 1879.

Locality.—Western Indian Ocean; W. L. Abbott, 1 male (18130).

The rostrum is much longer and narrower than in the example figured by Dana.

ECHINŒCUS, new genus.

Carapace subpentagonal, very convex in the antero-posterior direction. Rostrum triangular, flattened horizontally, strongly deflexed. Eyes small, in circular orbits, concealed by the carapace and situated at the indentation formed by the meeting of the antero-lateral and rostral margins. Antennæ very small, covered by the rostrum, the basal segment narrow. Maxillipeds with the merus notched at its antero-internal angle. Abdomen of female with 7 segments. Legs short.

ECHINŒCUS PENTAGONUS, new species.

Carapace almost smooth, convex in both directions, especially so in the antero-posterior directions; posterior margin straight, forming oblique angles with the postero-lateral margins, which are directed forward and outward. Antero-lateral angles rounded. Surface punctate. There are a few round shallow depressions between the areas, and seven or eight small low tubercles on the cardiac region. The rostrum is nearly as long as its breadth at base, thin-edged, obtuse and slightly indented at the tip. The eyes are withdrawn into small nearly circular orbits which are bordered below by the small narrow basal antennal segment. The flagellum is short, not reaching to the middle of the rostrum and is entirely concealed by it. The antennulæ are nearly longitudinal. Epistome short. The lower surface of the carapace is conspicuously punctate. Maxillipeds punctate; inner margin of merus convex, antero-internal angle with a slight notch. Abdomen of female much longer than wide.

Chelipeds short and stout, punctate; ischium with a low tooth on inner margin; merus trigonal, widening distally, with a stout tooth on each margin near the carpus; carpus with two teeth on inner margin.

When the chelipeds are folded close to the carapace, one carpal tooth is just in front of the antero-lateral angle, the other just behind it. Propodus deep, especially toward the fingers, where the upper margin is produced much above the dactyl. Fingers short, irregularly and feebly toothed along their prehensile edges which are in contact, the tips crossing. Ambulatory legs unarmed, somewhat flattened; meral joints rectangular; propodal joints tapering towards the dactyli which are stout, and hairy beneath, with curved horny tips.

Measurements.—Length of carapace, 15 mm.; width at antero-lateral angles, 14.3; posterior width, 8; width at orbits, 5.5; length of rostrum, 4.8; length of cheliped, 14; lower margin of propodus, 7; greatest depth of propodus, 3.7; length of first and second ambulatory legs, 15; third, 13.2; fourth, 12.5.

Locality.—Port Lloyd, Bonin Islands; from the anal end of the intestinal canal of *Echinothrix calamaria;* one adult female (13889).

This species with its smooth broad carapace and short legs is adapted for commensalism, and resembles superficially certain of the Pinnotheridæ of similar habit.

EPIALTUS BITUBERCULATUS, Milne-Edwards.

Epialtus bituberculatus, MILNE-EDWARDS, Hist. Nat. Crust., I, p. 345, pl. XV, fig. 11, 1834.—A. MILNE-EDWARDS, *op. cit.,* p. 139, pl. XXVII, figs. 1, 2, and 3, 1878, and synonymy.

Epialtus dilatatus, A. MILNE-EDWARDS, *op. cit.,* p. 140, pl. XXVII, fig. 4.

Represented in the collection by 10 specimens from 9 localities. A larger series would probably show that *E. sulcirostris* and *E. longirostris* Stimpson and *E. minimus* Lockington are variations of the same species.

Sabanilla, United States of Colombia; U. S. Fish Commission; 1 male (18131) of the form shown by A. Milne-Edwards, *op. cit.,* pl. XXVII fig. 3.

Pernambuco (?), Brazil; Richard Rathbun, Hartt Explorations, 1875-'77; 1 male, 1 female, also of the *brasiliensis* form, and the male with the heavy chelipeds figured by Dana.

Bird Key, Florida; U. S. Fish Commission schooner *Grampus,* April, 8, 1889; one female with eggs (15204) of the *dilatatus* form, the anterior lateral lobes being more rounded than in A. Milne-Edwards's figure, and the rostrum narrower at base and less tapering.

Dry Tortugas, Florida; Dr. Edward Palmer; one immature female (18132) of the *dilatatus* form, with lobes like the last.

Florida (?); one small male, (14465) with lobes intermediate between typical *bituberculatus* and *dilatatus.*

West coast of Florida; Henderson and Simpson; one immature female (18133), with elongate, emarginate rostrum and rather prominent lateral lobes, the anterior rounded, with its anterior margin sloping backward and outward, the posterior lobe with a prominent tubercle on its anterior margin.

Key West, Florida; D. S. Jordan, December, 1883; one male (18134), with rostrum similar to the last, and with acute somewhat spiniform lateral lobes.

Panama (?) ; one small female (18135) with eggs, with entire rostrum, and prominent lateral lobes, the anterior being rounded and its anterior margin sloping backward and outward, the posterior lobe smaller and acute.

Southern California; W. H. Dall; one male (18136); this specimen shows a greater divergence from typical forms than any of those hitherto described; the rostrum is broad and flat, widening toward the extremity which is broadly emarginate; the præorbital lobes are small but acute; the hepatic lobes are enormously developed, their anterior margins directed forward, outward and upward, their extremities being more advanced than the eyes. The postero-lateral projections are stout, acute teeth. The palms of the chelipeds are very long and terminate in a strong prominence behind the dactyl. Length 11.3 mm., width 9 mm.

EPIALTUS PRODUCTUS, Randall.

Epialtus productus, RANDALL, Jour. Acad. Nat. Sci. Phila., VIII, p. 110, 1839.—GIBBES, Proc. Amer. Assoc. Adv. Sci., III, p. 173, 1850.—DANA, *op. cit.*, I, p. 133, pl. 6, fig. 2, 1852.—STIMPSON, Proc. Acad. Nat. Sci. Phila., IX, p. 219, 1857; Bost. Jour. Nat. Hist., VI, p. 457, 1857.—RICHARD RATHBUN, Fisheries Industries of U. S., Sec. I, p. 778, pl. 268, 1884.

Localities.

Alaska:
- Kyska Harbor, 9 to 12 fathoms, sandy mud; W. H. Dall (14797).

British Columbia:
- Barclay Sound; U. S. Fish Commission (15521).
- Beaver Harbor; U. S. Fish Commission (15519).
- Victoria; C. F. Newcombe (15796).

Washington:
- Straits of Fuca; D. S Jordan (3061).
- Port Ludlow; W. H. Dall (14796).
- Port Orchard; O. B. Johnson (14974); U. S. Fish Commission (15518).

California:
- Tomales Bay (14853).
- San Francisco; D. S. Jordan (3095).
- San Francisco (?); U. S. Exploring Expedition (2366).
- Point Loma; U. S. Fish Commission (15522).
- Monterey; A. S. Taylor (2054); D. S. Jordan (3129); H. Hemphill (2289, 3292).
- Monterey Bay; U. S. Fish Commission (15520).
- Santa Barbara; Shoemaker (2316); D. S. Jordan (3048).
- San Pedro; D. S. Jordan (3088).
- Catalina Harbor, beach; W. H. Dall (14793).
- San Diego; D. S. Jordan (3560); Rosa Smith (7633); Rosa S. Eigenmann (14652); H. Hemphill (18137).
- Southern California; W. H. Dall (14794).
- West coast North America; North Pacific Railroad Survey (2139).

EPIALTUS (ANTILIBINIA) DENTATUS, (Milne-Edwards).

Epialtus dentatus, MILNE-EDWARDS, Hist. Nat. Crust. 1, p. 345, 1834.—BELL, Trans. Zool. Soc. London, II, p. 62, 1835.

Epialtus (Antilibinia) dentatus, MIERS, Jour. Linn. Soc. London, XIV, p. 650, 1879.

Localities.

Panama (?); J. M. Dow; 1 female (2402).
West Coast of South America; Dr. H. E. Ames, U. S. N.; 1 female (18138).
Callao, Peru; U. S. Exploring Expedition; 1 female (2365).
Valparaiso, Chili; U. S. Exploring Expedition; male and female (2367).

The specimens collected by the United States Exploring Expedition, although labeled by Dana, were omitted from his report.

EPIALTUS (ANTILIBINIA) MARGINATUS, (Bell).

Epialtus marginatus, BELL, *op. cit.*, p. 62, pl. XI, fig. 4 (♀), pl. XIII (♂).—A. MILNE-EDWARDS, *op. cit.*, p. 138, 1878.

Epialtus (Antilibinia) marginatus, MIERS, *loc. cit.*

Locality.—Valparaiso; U. S. Exploring Expedition; male and female (2372). Labeled but not recorded by Dana.

EPIALTUS (ANTILIBINIA) NUTTALLII, (Randall).

Epialtus nuttallii, RANDALL, Jour. Acad. Nat. Sci. Phila., VIII, p. 109, pl. III, 1839.

Localities.

Santa Barbara, Cal.; D. S. Jordan, 1880 (3108).
San Diego, Cal.; H. Hemphill; 7 young females (18139).
Southern California; W. H. Dall; 1 young female (14798).

PUGETTIA GRACILIS, Dana.

Pugettia gracilis, DANA, *op. cit.*, I, p. 117, pl. 4, fig. 3.—STIMPSON, *op. cit.*, p. 456. LOCKINGTON, Proc. Cal. Acad. Sci., VII, p. 76, 1876.—MIERS, Jour. Linn. Soc. London, XIV, p. 650, 1879; *Challenger* Rept., Zool., XVII, p. 40, 1886.

Pugettia lordii, SPENCE BATE, in Lord's Nat. in Brit. Col., I, p. 265, 1866.

Pugettia quadridens var. *gracilis*, ORTMANN, Zool. Jahrb., VII, 1, p. 43, 1893.

In many specimens the wing-like lateral expansion is strongly upturned, and there are four tubercles on each branchial region, one in line with the cardiac tubercle, one further back but nearer the median line, while the other two are further forward on the branchial region. The upper surface and margins of the rostral horns and the inner margin of the præorbital teeth are marked with lines of curled setæ. The carpus of the cheliped, besides the two carinæ above, has a strong carina on the inner margin, and is irregularly ridged on the outer surface. In large males, the hands are very wide, compressed, with the upper carina very thin and prominent; fingers gaping at base, with a short, stout tooth on the dactyl.

The color of dried specimens recently received from Dr. Newcombe is red and green above, and red beneath.

Measurements.—Length of largest specimen, 53 mm.; branchial width, including spines, 40; length of cheliped, about 86; width of hand, 18.

There is nothing in the description or figure of *P. lordii* Spence Bate to indicate that it differs from *P. gracilis*. It is said to range southward to San Francisco.

This species differs from *P. quadridens* in its greater proportionate width at the hepatic regions. In *P. quadridens* the carapace is obviously triangular, being much wider posteriorly than anteriorly, while in *P. gracilis* the carapace is very little wider at the branchial regions than at the hepatic. The anterior lateral expansion has its posterior lobe produced much further forward than in *P. quadridens*; its outer or posterior margin is very convex, while in *P. quadridens* it is concave except near the end of the lobe. The præorbital lobes are wider and the orbital sinus narrower in *P. gracilis* than in *P. quadridens*. In *P. gracilis* the four gastric tubercles (the anterior one is obsolete in old specimens) form a Latin cross; in *P. quadridens* they form a rectangle. The ambulatory legs are more slender in *P. quadridens*.

Localities.

Alaska; William H. Dall:
- Chichagoff Harbor, Attu, 5 to 7 fath., gravel, sand (14756).
- Kyska Harbor, in pass, 10 fath. (14759).
- Nazan Bay, Atka, low water (14757).
- Off Imagna Pinnacle, Captain's Bay, Unalaska, 8 to 20 fath. (12538).
- Amaknak Island, shores (13131).
- Belkoffsky Bay, 15 to 25 fath. (14754).
- Popoff Strait, Shumagins, 6 fath. (14753).
- Chirikoff Island, beach (15375).
- Middleton Island, west side, 10 to 12 fath., gravel, stones (14758).
- Port Mulgrave, Yakutat Bay, 6 to 40 fath. (14763).
- Lituya Bay, 6 to 9 fath. (14764).

Alaska; other collectors:
- Unalaska; S. Applegate (12050).
- Kadiak; W. J. Fisher (5747); U. S. Fish Commission (15571).
- Sitka; Commander L. A. Beardslee, U. S. N. (3171); F. Bischoff (2178).
- Ward Cove, Revilla Gigedo Island; Dr. T. H. Streets, U. S. N. (14761).
- Alert Bay, Cormorant Island, beach; Dr. W. H. Jones, U. S. N. (5815).

British Columbia:
- Tledoo Village, near Susk, northwest coast of Graham Island, Queen Charlotte group; James G. Swan (6611).
- Barclay Sound; U. S. Fish Commission (15570).
- Victoria; Dr. C. F. Newcombe (15795).

Washington:
- Straits of Fuca (3400); D. S. Jordan (3077).
- Neah Bay; J. G. Swan (2396, 5771).
- Port Angeles; U. S. Fish Commission (18140).
- Port Townsend; U. S. Fish Commission (16033).
- Port Ludlow; S. Bailey (14762); W. H. Dall (14755).
- Puget Sound; D. S. Jordan (3097).
- Port Orchard; O. B. Johnson (14967).

PUGETTIA RICHII, Dana.

Pugettia richii, DANA, *op. cit.*, I, p. 118, pl. 4, fig. 4.—STIMPSON, *op. cit.*, p. 457.—LOCKINGTON, *loc. cit.*—MIERS, *loc. cit.*

This species is not larger than *P. gracilis*, and in adult specimens the hands and fingers do not differ in the two species. *P. richii* is, however, readily distinguished by the bilobate lateral expansion, the posterior lobe of which is slender and almost transverse, and the anterior lobe more transverse than in *P. gracilis*. The merus has a few irregular teeth above instead of the prominent carina of *P. gracilis*. Carpus with a single carina above and one on the inner margin, and between them but a slight trace of the diagonal ridge so prominent in *P. gracilis*. Ambulatory legs more slender and cylindrical than in *P. gracilis*.

Localities.

British Columbia
- Barclay Sound; U. S. Fish Commission (15572).
- Victoria; Dr. C. F. Newcombe.

California:
- Monterey Bay; U. S. Fish Commission (15573).
- Monterey; H. Hemphill (2276); D. S. Jordan (3058).
- San Diego; Rosa Smith (14765).

PUGETTIA QUADRIDENS, (de Haan).

Pisa (Menæthius) quadridens, DE HAAN, Fauna Japon., Crust., p. 97, pl. XXIV, fig. 2, male, and pl. G, 1850.

Pisa (Menæthius) incisus, DE HAAN, *op. cit.*, p. 98, pl. XXIV, fig. 3, female, and pl. G.

Menæthius quadridens, ADAMS and WHITE, Voy. Samarang, Crust., p 20, 1848.

Menæthius incisus, ADAMS and WHITE, *loc. cit.*

Pugettia quadridens, STIMPSON, Proc. Acad. Nat. Sci. Phila., IX, p. 219, 1857.—MIERS, Proc. Zool. Soc. London, p. 23, 1879; Challenger Rept., Zool., XVII, p. 40, 1886.

Pugettia incisa, STIMPSON, *loc. cit.*—MIERS, *loc. cit.*

After careful study of a large series of specimens of this genus from Japan I find it necessary to unite De Haan's two species. There are specimens in the collection as distinct as those figured by De Haan. In a lot of four examples from Yokohama Bay three represent the typical *P. incisa*, while one has the hepatic expansion more projecting and more concave on the margin. Rev. H. Loomis has recently presented to the Museum 60 dried specimens from Japan, exact locality not given. Of these about 25 have the strongly produced lateral expansion with a deep sinus separating the postorbital tooth from the sharp posterior tooth. About 10 specimens have the narrower carapace, almost truncate lateral expansion with a rounded posterior angle. The remainder of the specimens are intermediate in width, with the hepatic margin more or less concave and its posterior angle subacute. The prominence of the median tubercles varies with the individual.

In male specimens of both varieties 25 mm. long the chelipeds are identical; the palms are slightly constricted behind the fingers, which are evenly dentate and in contact for nearly their whole length. There

are no larger examples of the *P. incisus* type in the collection, but specimens of the *P. quadridens* type and of the intermediate grade, about 35 mm. long, have chelipeds proportionally much larger, hands of nearly equal width throughout, fingers dentate for nearly their entire length, in contact for their terminal half, gaping at base, and without the two prominent isolated teeth at the base of the dactyl represented in De Haan's figure of *P. quadridens.*

Aside from the characters on which De Haan's two species were founded—the shape of the carapace and the development of the chelipeds—there seem to be no specific differences.

Localities.

Yokohama Bay, Japan, 7 fathoms, kelp (13918).

Japan; H. A. Ward (18141); H. Loomis (18142); Dr. F. C. Dale, U. S. S. *Palos* (13720, 13726).

Fusan, Corea; P. L. Jouy (12400).

PUGETTIA FOLIATA, (Stimpson).

Mimulus foliatus, STIMPSON, Ann. Lyc. Nat. Hist. N. Y., VII, p. 200, 1860.

There seems to be no good reason for placing this in a genus distinct from *Pugettia.* The antennæ have the basal joint as in that genus and the flagellum flattened and exposed at the sides of the rostrum. The lateral expansion is bilobate, but the carapace is wider than in other species of *Pugettia.* The breadth of the carapace does not always exceed the length, as, for instance, in the specimen from Barclay Sound, where the dimensions are: Length, 12.5 mm.; width, 12 mm. The chelipeds present nothing distinctive; the manus is very broad and has thin upper and lower margins. The maxillipeds, abdomen, sternum, and ambulatory legs are almost exactly as in *P. gracilis.*

Localities.

Off Imagna Pinnacle, Captain's Bay, Unalaska, 8 to 20 fathoms; W. H. Dall (14894).

Barclay Sound, B. C.; U. S. Fish Commission (15548).

Monterey, Cal.; H. Hemphill (3291).

ACANTHONYX PETIVERII, Milne-Edwards.

Acanthonyx petiverii, MILNE-EDWARDS, Hist. Nat. Crust., I, p. 343, 1834.—A. MILNE-EDWARDS, *op. cit.*, p. 143, pl. XXVII, fig. 7, and synonymy.

Localities.

Mar Grande, Bay of Bahia, Brazil, Richard Rathbun, Hartt explorations 1875-'77; one female.

Pernambuco (?), same collector; male and female.

Subfamily MICRORHYNCHINÆ.

NEORHYNCHUS DEPRESSUS, (Bell).

Microrhynchus depressus, BELL, Trans. Zool. Soc. Lond., II, p. 42, pl. 8, fig. 2, 1835.
Neorhynchus depressus, A. MILNE-EDWARDS, *op. cit.*, p. 187, 1879.

Hitherto only the female of this species has been known. The abdomen of the male has a long, acute, horizontal spine on the first segment as in the female; the outer margins of the fifth and following segments are nearly parallel; terminal segment rounded; sixth and seventh anchylosed. The abdomen figured by Bell is that of an immature female; in mature females the fifth or anchylosed segment is much wider than long, the distal margin slightly concave. The chelipeds of the male are weak as in the female. Of the ambulatory legs the second pair is the longest and the first the shortest, fringed with long hairs; second pair less hairy, third and fourth pairs slightly hairy. Last pair shorter than the third. The basal antennal joint has the inner margin irregularly dentate, the antero-internal tooth blunt, not so far advanced as the antero-external, which is slightly incurved, rounded.

Measurements.—Length of carapace (of largest specimen, a female), 18; width, 17; length to tip of abdominal spine, 23 mm. Length of carapace (of male), 12.5; width, 11.5 mm.

Locality.—Gulf of California, lat. 24° 16′ N., long. 110° 22′ W., 21 fathoms, gray sand, broken shells, April 30, 1888; station 2822, U. S. Fish Commission steamer *Albatross* (18143).

PYROMAIA CUSPIDATA, Stimpson.

Pyromaia cuspidata, STIMPSON, Bull. Mus. Comp. Zool., II, p. 110, 1870.—A. MILNE EDWARDS, *op. cit.*, p. 177, pl. XXXVI, fig. 2, 1879.
Apiomaia cuspidata, VON MARTENS, Zool. Rec., 1871, p. 182.—MIERS, Jour. Linn. Soc. London, XIV, p. 651, 1879.

The *Albatross* specimens of this species are much larger than those described by Stimpson and A. Milne-Edwards. The dorsal spines are not short and tuberculous, but slender and prominent; of those on the median line, the posterior gastric, the anterior cardiac, the posterior, and the abdominal spine are longer than the others. There is an acute triangular interantennular spine, pointing forward. The chelipeds of the adult male are stouter than those figured by A. Milne-Edwards and are spinulous. Merus with longitudinal rows of short spines with one longer and very slender spine at its distal upper extremity. All the spinules or spines of the carpus are short. The basal portion of the propodus is tumid, longer than the fingers, which touch almost to their base where there is a slight opening. The ambulatory legs are spinulous; the meral joints have an erect spine near the ischial joint, and short spines on the condyles articulating with the carpal joints.

In females and young the ambulatory legs are almost smooth to the touch, but the spinules can be seen with the lens. A female, 27 mm. long, bearing eggs, from station 2601, is unique in having no spine at

the base of the merus of the ambulatory legs, a character which is present in all other specimens of all sizes, more than thirty of which have been examined.

Measurements.—Entire length of carapace (of male), 45; width, without spines, 35; length of cheliped, 73; propodus, 33.5; pollex, 15; depth of propodus, 8.5; length of first ambulatory leg, 152; second, 144; third, 136.5; fourth, 123.

Localities.

Off Cape Lookout, N. C., to the Gulf of Mexico; U. S. Fish Commission steamer *Albatross*, as follows:

Cat. No.	Station.	Lat. N.	Long. W.	Bottom.			Date.
				Fathoms.	Temp.	Materials.	
		° ′ ″	° ′ ″		° F.		1885.
9649	2377	29 07 30	88 08 00	210	67	gy. M	Feb. 11
9745	2399	28 44 00	86 18 00	196	51.6	gy. M	Mar. 14
18144	2400	28 41 00	86 07 00	169	....	gy. M	Mar. 14
9750	2401	28 38 30	85 52 30	142	....	gn. M. brk. Sh	Mar. 14
9758	2402	28 36 00	85 33 30	111	....	gy. M	Mar. 14
18145	2601	34 39 15	75 33 30	107	....	gy. S. P	Oct. 18
18146	2602	34 38 30	75 33 30	124	....	S. R	Oct. 18

LOXORHYNCHUS GRANDIS, Stimpson.

Loxorhynchus grandis, STIMPSON, Jour. Boston Soc. Nat. Hist., VI, p. 452, pl. XIX, fig. 1, pl. XXII, fig. 1, 1857.

Localities.

California:

Near San Francisco; Trowbridge (15376).

Off Santa Barbara, lat. 34° 19′ 30″ N., long. 119° 44′ 15″ W., 68 fathoms, green mud, temperature 54°, February 11, 1889, station 2973; U. S. Fish Commission steamer *Albatross* (17379).

San Diego; Dr. Kennerly (17572).

LOXORHYNCHUS CRISPATUS, Stimpson.

Loxorhynchus crispatus, STIMPSON, Jour. Boston Soc. Nat. Hist., VI, p. 453, pl. XXII, figs. 2, 3, and 4, 1857.

In a large male the nine most prominent spines or tubercles are covered, excepting at the top, with very thick short hair, which makes them appear hemispherical in shape with small shining points emerging from the hair. There are three less prominent spines arranged transversely on the postfrontal region, and a number of smaller spines scattered on the carapace. Rostrum covered above with stout curled hair, which extends back from each horn across the gastric region; the line is then broken and reappears lower down, and is continued along the branchial region. Chelipeds covered with short hair, except the fingers and places where the hair has been worn off; merus midway between the joints, almost rectangular; upper margin armed with two stout spines widely separated and a smaller one near the ischium; upper surface with a large tubercle at the distal end between the condyles; carpus with five or six spiny tubercles above; hand with two

spines above, one near the carpus on the upper margin, and the other at a little distance just below the margin on the inside of the hand; occasionally there are one or two additional spines on the margin; fingers gaping at base with a large tooth on the dactyl in the gape and about 15 small even teeth on each finger along their prehensile edges.

Smaller males have the spines of the chelipeds much less marked.

In the female the carapace shows twelve tubercles of about equal size, those corresponding to the nine largest ones of the male, being smaller in the female. Chelipeds small and weak; fingers slightly gaping at base, with about 20 small teeth, the proximal one on the dactyl being slightly enlarged. The female is much more hairy on the legs and underneath the abdomen and margins of the legs being thickly set with long club-like setæ.

Specimens in the National Museum collection show the following measurements: Length of largest specimen, a male, from end of rostrum to overhanging posterior protuberance, 122 mm.; width, 84; length of cheliped, about 272; of first ambulatory leg, about 205. Length of largest female measured to posterior margin, the intestinal spine not overhanging, 90; width, 57; length of cheliped, 95; of first ambulatory leg, 80.

Localities.

California:

Monterey; D. S. Jordan (5876).

Santa Barbara; D. S. Jordan (3050).

Island of San Miguel; Trowbridge (2083).

Off southern California, 26 to 53 fathoms, at nine stations of the U. S. Fish Commission steamer *Albatross*.

ON THE FORMATION OF STALACTITES AND GYPSUM INCRUSTATIONS IN CAVES.

By George P. Merrill,
Curator of the Department of Geology.

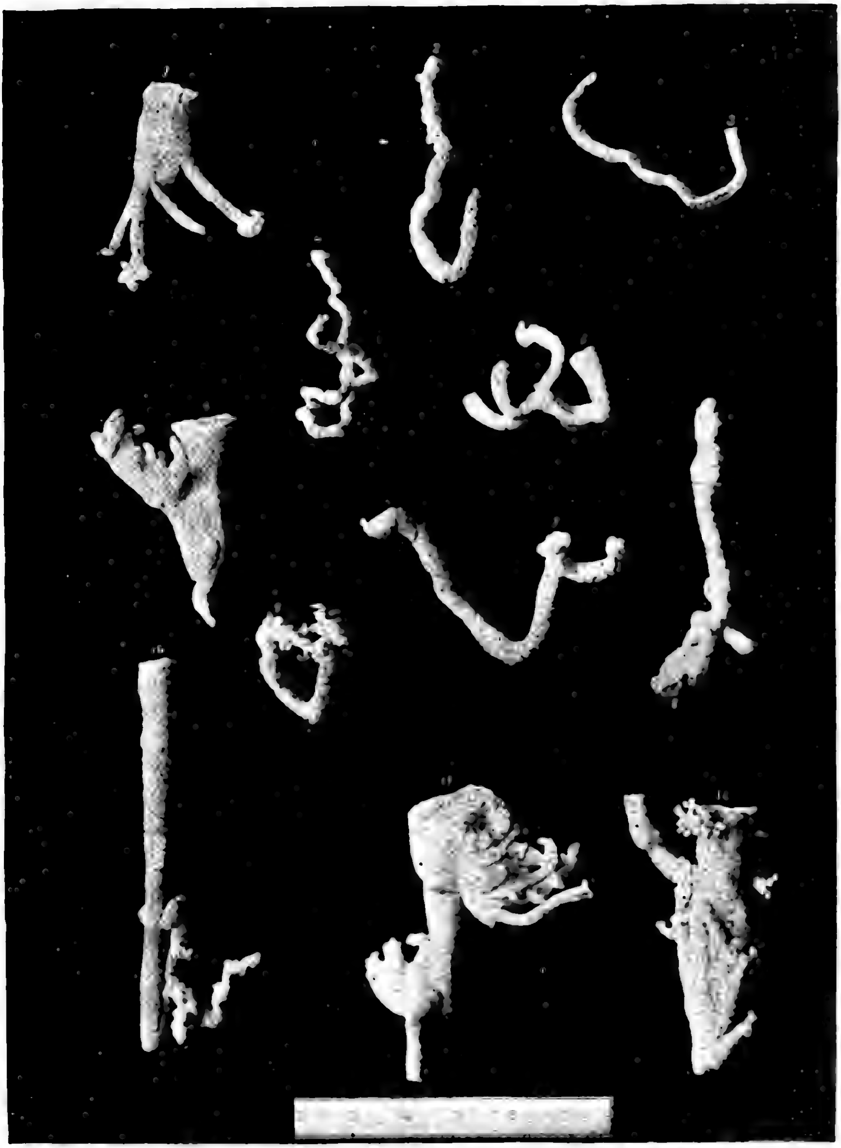
During the season of 1893 work in connection with the World's Columbian Exposition took the writer into a considerable number of the limestone caverns of the eastern United States and afforded him opportunity for observations regarding the methods of formation of the interesting deposits noted in the title. The results of these observations are given herewith, it having seemed to me that, while no new principle is involved, the subject as a whole has not received all the attention it deserves.

Stalactites.—The manner in which the carbonate of lime in the form known as stalactite and stalagmite is deposited is, in brief, as below: Water filtering through the roof of a limestone cavern, is, in virtue of the carbonic acid it contains, enabled to dissolve a small amount of the lime carbonate, which is again deposited when the excess of carbonic acid escapes either through relief from pressure or the evaporation of the water. Conditions favorable to either process are furnished by the water filtering through the roof and dripping slowly to the floor beneath. In cases where the water filters sufficiently slowly, or evapooration is correspondingly rapid, the deposit of lime carbonate from the roof takes at first the form of a ring around the outer portion of the drop, a natural consequence of the evaporation of a suspended drop of liquid, as may readily be shown by laboratory experiments. This process may go on until the ring becomes prolonged into an elongated cylinder, or tube, the diameter of which may not exceed five millimeters, though usually ranging from five to ten, and of all lengths up to 50 cm. In exceptional cases this length may be exceeded, but owing to the delicacy of the material, the stalactite usually breaks of its own weight and falls to the floor before a length of even 100 or 150 mm. is reached, to become imbedded in the stalagmitic material there forming. Lengths of even these dimensions are comparatively rare for the reason that the tube becomes shortly closed, either at its

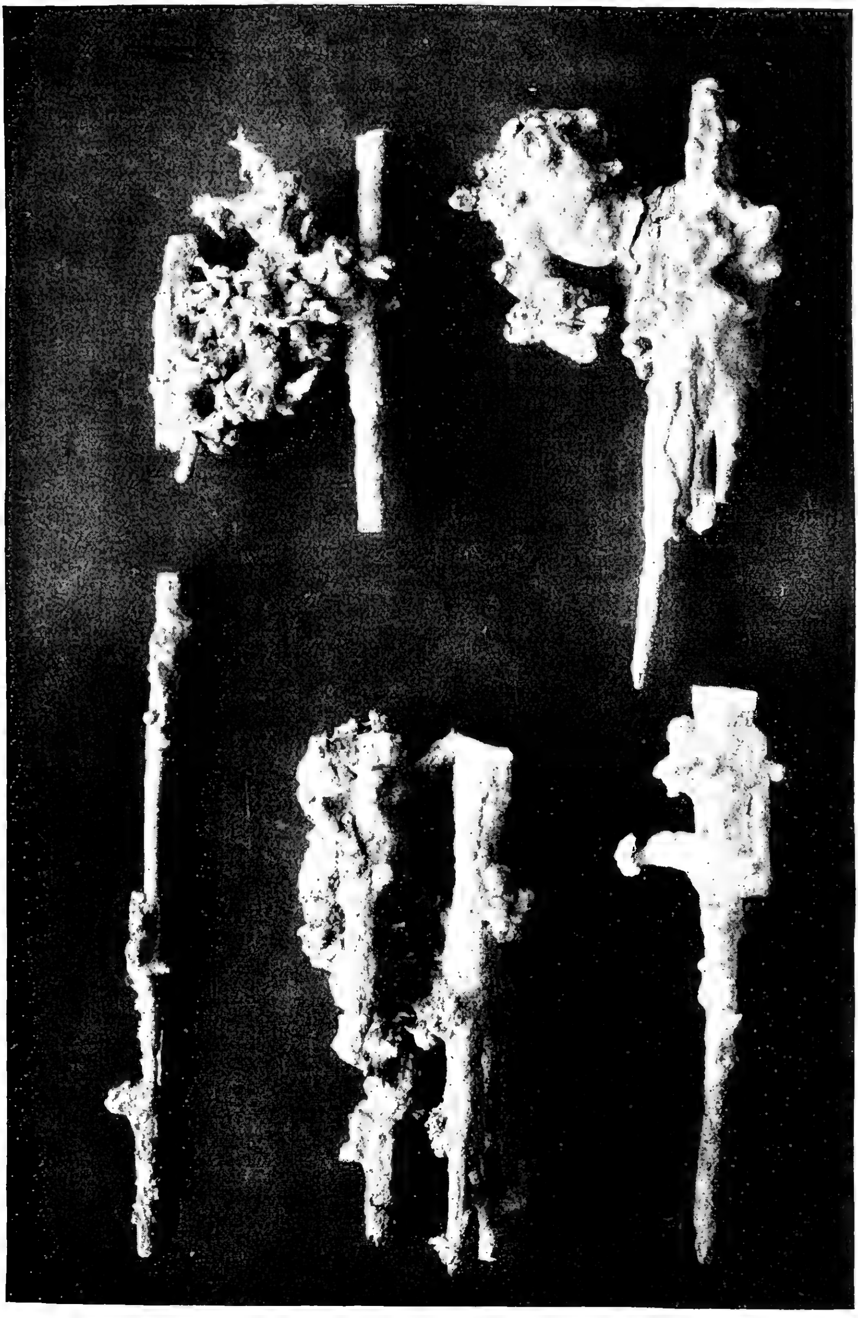
upper or lower end, usually the upper, and all growth from the extremity alone ceases, subsequent deposition being wholly exterior, and taking place in the form of concentric coatings of the carbonate on the outer surface and at the same time from the top. There is thus formed around the original tube a compact cylindrical mass, in its typical form constricted at point of attachment but thickening rapidly, and then tapering gradually into an elongated cone. The material of the stalactite is not always wholly carbonate of lime, but in some cases thin intervening coats of iron disulphide are met with; these are rarely more than a millimeter or so in thickness. Such forms have been found in the caverns of Luray, in Virginia. The presence of a magnesian carbonate in these deposits has not been detected in any amount. Through a crystallization which must be nearly contemporaneous with deposition, or at least while the stalactite is still saturated with the carbonated waters, the mass of the material undergoes an arrangement which is sometimes distinctly fibrous (aragonite), the fibers radiating from the center outward, and not infrequently being curved downward —that is, curved in such a manner that when the stalactite is broken across it shows a concave and convex fracture, the concavity being uppermost—toward the top of the stalactite. In other cases the structure is granular throughout, through the development of calcite rhombs. In the stalactites from Weyer's Cave, Shendun, Virginia, the entire center is sometimes occupied by large (10 mm.) rhombs of clear calcite, from which radiate horizontally elongated forms of the same mineral. It is safe to assume that such crystallizations are wholly secondary.

It is a natural consequence of their method of deposition that stalactites of the type described above are as a rule nearly straight, and hang approximately perpendicularly from the roof. Exceptions to this rule will be noted below.

In the Wyandotte Cave, and to a less extent in some others, a peculiar vermiform stalactite is found which is quite at variance with those described above. They occur in clusters or groups both on the walls and ceiling and are remarkable for their peculiar fantastic twistings and turnings, which in extreme cases are almost Medusa-like. Their appearance can best be understood by reference to Pl. I, the scale being in inches. This shows a number of detached stalactites both simple and branching. The point of attachment is uppermost in the figures, with but one exception. In order that there be no misunderstanding I have placed the numbers always at the broken end. It will be observed that the processes of deposition already described fail to satisfactorily account for these forms, in which the law of gravity seems to have been set at defiance. In fig. 2, it will be noticed, the stalactite after growing irregularly downward for about 4 inches turned upward and grew in this direction for half its length. No. 3 grew downward for an inch or so, and then in a nearly horizontal and upward direction for three or four inches. Number 4 is a singularly contorted



IRREGULAR STALACTITES, WYANDOTTE CAVE, INDIANA.



IRREGULAR STALACTITES, LURAY CAVES. PAGE COUNTY, VIRGINIA.

form, having turned on itself and grown irregularly upward till its free, growing end, was within an inch and a half of the starting point, or point of attachment. This stalactite weighs, entire, only some 21 grms Number 5, after growing downward a short distance turned to the left for about the same distance and then threw out three branches, which, when the specimen was collected, had grown upwards until they nearly touched the roof. (Cat. No. 68140.)

In the caverns of Luray, Virginia, are likewise occasionally found peculiar distorted forms, though of a nature quite different from those of Wyandotte, as may be observed by reference to Pl. III. These lack entirely the vermicular forms characteristic of the last named, and may be best compared with the peculiar wart-like excresences and knurly branches which sometimes appear on trees, as a result of injury from insects. Such have been called helictites (from the Greek ἕλιξ a spiral.)

The cause of these singular distortions of form has not, so far as I am aware, been satisfactorily determined. Dr. Hovey, in his Celebrated American Caverns (p. 185) ascribes the Luray forms to "lateral outgrowths, having fungi for starting points," or, in other cases to crystals shooting from the side of a growing stalactite thus transforming it into some grotesque shape. In his later writings he has seemed to incline more to the view of considering them as "tricks of crystallization." Dr. C. S. Dolley* was inclined to regard these horizontal off-shoots as due to spider webs. He says:

After some time spent in a vain search for an explanation of this anomalous structure, we happened to notice two specimens, the incipient branches of which were directed toward one another; stretched tightly between the branches, and entering the hollow tip of each, was a delicate thread, bearing a string of dew-like drops glistening brightly in the candlelight. Further search revealed numerous specimens in which the lime water trickling down the stalactite met a similar filament, and being partially diverted had formed a drop at point of junction; about this drop beautiful aragonite spicules were forming the hollow horizontal branch, the drop of water in the end being retained in position by the filament piercing it and upon which it gradually pushed along as evaporation deposits the lime behind it."

Dr. Brezina in his "Wie Wachsen die Steine" describes distorted forms as due to currents of air, but inasmuch as those of Wyandotte Cave radiate in every direction, it is obvious that they can not be thus accounted for. Prof. Collett in describing these last, in 1878, speaks of their growing from the bottom outward,† an error which can, I think, be accounted for only on the supposition that at the time of writing his thoughts were fixed upon the peculiar gypsum efflorescences (to be described later) and which are thus formed.

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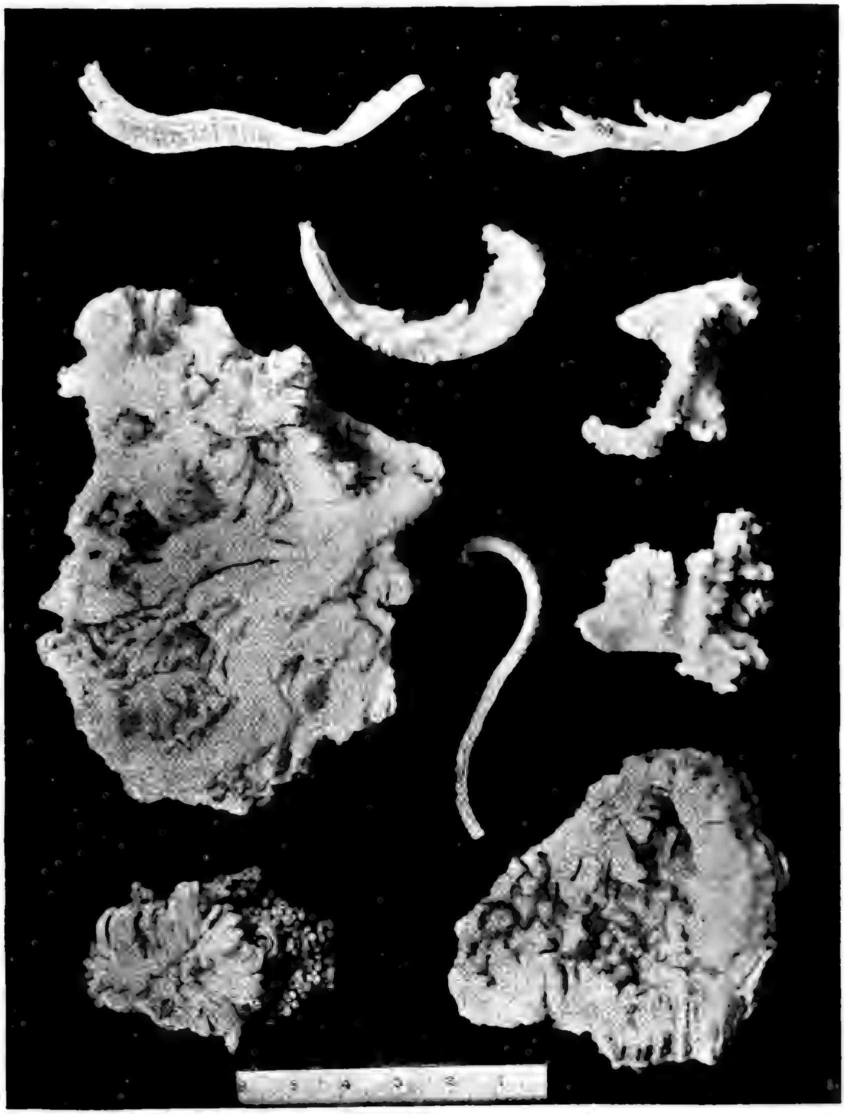
* Proc. Acad. of Nat. Sciences, 1886, p. 351.

†"The Pillared Palace is entered by a broad doorway, flanked by stalacto-stalagmites, while within, ceiling, cornices, and shelves are fringed with stalagmites and frosted with a never ending medley of strange, crooked, writhing, twisting unsymmetrical sprigs of white limestone, pushed out of the solid rock, and still growing by propulsion from the bottom; one cluster is a realization in stone of the horrible, snaky tresses of Medusa." John Collett, in Rep. Geol. Sur. of Ind., 1878, p. 475–76.

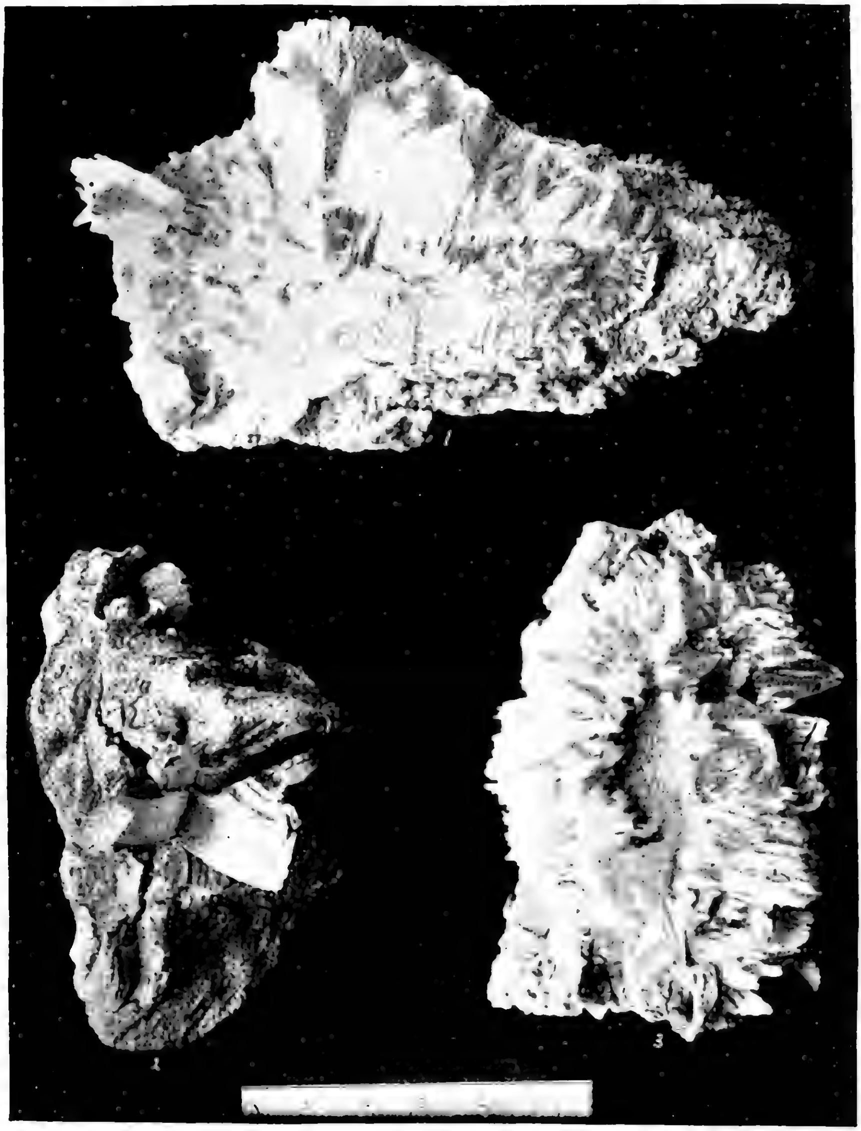
It is probable that the various forms of distortion and departure from the straight tubular forms are to be accounted for in several ways. An examination of the Medusa-like forms of Wyandotte reveals the fact that they occur not as dependents from the naked limestone of the roof, but are offshoots from a stalactitic crust which forms first, and which varies from a mere film to several inches in thickness. They occur sometimes singly, but more commonly in groups, or clusters of several, ranging in sizes from 3 to 10 mm. in diameter. Closer inspection reveals the fact that while in most cases tubular, the tube itself is of almost microscopic proportions, being as a rule less than half a millimeter in diameter. So small is it, in fact, that capillarity, not gravity, is the controlling principle in giving direction to the lime-carrying solution. A small spicule of calcite crystalizing on the extremity is as likely to point any other direction as downward: the direction of the next drop is controlled in part by the first, where the same process is repeated. Or on the assumption that the stalactite increases in length by constant additions to the tube, on all sides, it is easy to imagine that the deposit takes place, for a time, more rapidly on one side than on the other, perhaps partially closing the orifice or giving it a different direction. The essential fact is, however, that it is to capillarity, and not to gravity, that is due the peculiar vermicular forms. Why, at the outset, the stalactite should begin to form through many small capillary tubes rather than through one larger, as is ordinarily the case, I will not pretend to say. It is to be noted, however, that in Wyandotte, the roof forming limestones are nearly horizontal, while in Luray and many other caves they are highly tilted. This results in a more even percolation of the water in the first instance, the roof being more homogeneous. It is possible, therefore, that the water gathers in drops of smaller size, and very likely in smaller amounts. I have no other than hypothetical data for this last assumption, however.

The peculiar warty and distorted forms shown on pl. III, from Luray, I believe to be also due to the action of capillarity. In this case, however, the side excrescences are of secondary growth, the stalactite having first formed, in part at least, in the ordinary way. Through a closing of the tube at the lower extremity, the water either oozed through the wall or perhaps ran down over the outer side until some slight irregularity being met, it paused long enough for the necessary precipitation to take place. Such forms are, in brief, but "tricks of crystallization" due to capillarity.

Gypsum incrustations and rosettes.—As is well known, Wyandotte and Mammoth Caves yield in their older, dry, chambers, not stalactites of carbonate of lime, but incrustations of gypsum in botryoidal masses, acicular crystals, and sometimes in the form of beautiful snow-white rosettes composed either of thin blades or acicular crystals of gypsum grouped around a common center and curving outward. The appearance and structure of characteristic forms may be best understood by



GYPSUM INCRUSTATIONS, MAMMOTH CAVE, KENTUCKY.



GYPSUM INCRUSTATIONS, WYANDOTTE CAVE, INDIANA.

reference to Pls. IV and V. The individual blades are rarely more than a few inches in length, six and eight inches being the maximum of the single curved blades such as are shown in Pl. IV. (Cat. No. 68142.) In fig. 2, Pl. V, the longer blades are 90 mm., by about 24 mm. breadth and 5 mm. thickness. This is in many respects the most remarkable specimen of its kind I have ever seen. The method of growth of these forms is plainly by additions to the bottom, or more properly, to the end attached to the wall. They seem to have grown outward precisely as does the hoar frost in loose soil, where the moisture, rising by capillarity, freezes as soon as a certain level is reached, so that the older and first formed portions are ever pushed upward so long as the supply below is continued. As in the formation of hoar frost, particles of earth are lifted upon the tops of the ice spicules, so here the growing gypsum having begun forming in a crevice not infrequently forces off pieces of the limestone of considerable size. In fig. 2, Pl. V, the force of the growing crystals has even ruptured the stone in three directions. In fig. 1 of the same plate we have proof of two stages of growth. The last formed crystals having pushed the first formed nearly an inch out of place, the line of separation between old and new being indicated by the smaller size of the later formed spicules. As the crystals form and are pushed outward they are in most cases in a condition of strain, which causes them to curl and twist in a remarkable manner, as shown. The individual blades or spicules are but slightly attached to the walls of the cave, and except under very favorable circumstances it is nearly impossible to remove a rosette in a condition at all satisfactory.

DESCRIPTIONS OF A NEW GENUS AND FOUR NEW SPECIES OF CRABS FROM THE ANTILLEAN REGION.

By Mary J. Rathbun,
Aid, Department of Marine Invertebrates.

The crabs described below were, with one exception, obtained in the extended cruise of the United States Fish Commission steamer *Albatross* to the Gulf of Mexico and Caribbean Sea in 1885. The species of *Actæa* formed a part of the large collection of invertebrates brought from Florida by Dr. Edward Palmer in 1884.

Family Parthenopidae.

THYROLAMBRUS, new genus.

Carapace broader than long, deeply eroded. Frontal and antero-lateral region strongly deflexed. Entire surface covered with stellar granules, which unite to form ridges outlining irregular pits. Maxillipeds broad, fitting closely together and filling the buccal cavity; ischium subrectangular posteriorly, slightly oblique anteriorly; merus broader than long, with a slight notch at the antero-internal angle, in which the first joint of the palpus is fitted in a transverse direction; the remainder of the palpus is concealed beneath the merus. Chelipeds of moderate length; manus much more slender than the merus and armed on the inner or anterior side with 2 rows of long, sharp, curved spines, which are continued on the fingers.

THYROLAMBRUS ASTROIDES, new species.

Carapace about two-thirds as long as wide, thick, slightly wider at the postero-lateral than at the lateral angles; frontal and antero-lateral regions almost perpendicular. Posterior margin directed slightly forward and outward. Besides the small pits everywhere present on the surface there are other larger depressions. A deep hollow between the orbits is continued backward by a shallow sulcus to the post-medial region. Two deep depressions occur at the inner branchial angles. The cardiac area is well defined and is bounded posteriorly by a trans-

[Advance sheets of this paper were published March 30, 1894.]

verse linear sulcus. The hepatic region is outlined by a series of depressions. The ridges of the surface are elevated at intervals into rough acute tubercles. Rostrum very broad, arcuate as seen from above, produced downwards at the middle in a small, triangular, denticulate tooth which extends backward to the antennular cavities. Orbits small, circular; eye-peduncles covered with stellar granules, and with a row of 3 or 4 spinules next the cornea on the upper side. Hepatic region with a triangular marginal tooth. Lateral margin of the branchial region with about 7 small granulate teeth. Teeth of posterior margin very shallow. Antero-internal angle of the basal antennal joint barely touching the front. Exognath of maxilliped slender; endognath with a longitudinal row of 3 spinules. The pterygostomian groove is continued on the subbranchial regions. The sternum in the male has 3 prominent ridges on either side of the abdomen, and is deeply hollowed at the anterior end.

Merus of cheliped thick, with short spines on the anterior and upper surfaces. Carpus with 3 spinules on inner margin. The spines of the propodus and dactylus number 5 or 6 in the lower series and 6 or 7 in the upper. They are curved inward and directed toward the extremity of the fingers. The fingers are slender, curved inward, their tips prolonged in sharp spines; the stellar granules are arranged longitudinally; prehensile edges armed with fine sharp irregular teeth or spines. The ambulatory legs are very rough. The meral joints have 1 crest above and 2 below. Dactyli short and slender, armed with sharp spines, and terminating in an acuminate horny tip.

Measurements.—Length of female, 16 mm.; width, 23·5; thickness at epistome, 6; length of cheliped, about 32; length of merus, below, 11; length of propodus, 14. Length of male, 14; width, 20; length of cheliped, about 34; of merus, 12; of propodus, 15.

Locality.—Off Havana, Cuba, in lat. 23° 10′ 42″ N., long. 82° 18′ 24″ W., 67 fathoms, white coral, 2 females (No. 9507, U. S. N. M.); and in lat. 23° 10′ 40″ N., long. 82° 20′ 15″ W., 189 fathoms, coral, 1 male (No. 9515, U. S. N. M.).

SOLENOLAMBRUS DECEMSPINOSUS, new species.

Closely allied to *S. typicus*, Stimpson. Antero-lateral margin convex, area between the gastric ridges narrower than in *S. typicus*, gastric and cardiac prominences slender spines. There are 8 additional dorsal spines: 2 on each branchial ridge, of which the marginal is the longer, 1 at each posterior angle, and 1 on the postero-lateral margin midway between the last and the branchial spine. The punctures of the carapace are very fine and scattered; in *S. typicus* they are coarse and anteriorly crowded. The sternum (in the male) is smooth in front of the abdomen. The terminal segment of the abdomen is much longer and narrower distally than in *S. typicus*, its sides deeply concave. The merus of the maxillipeds is narrower and more produced at the antero-external angle than in *S. typicus*.

The chelipeds are similar in ornamentation to those of *S. typicus;* the upper margin of the outer surface of the manus is furnished with 10 granulated teeth, the lower margin with about 12; as in *S. typicus*, the surfaces of the palm have bunches of granules arranged in 2 longitudinal rows. The immovable finger is shorter and more deflexed than in *S. typicus*, and in consequence the dactylus is also more deflexed, being, when closed, nearly at a right angle with the outer or upper surface of the palm. Color of fingers in alcohol, red.

Measurements.—Length of carapace of male, 6 mm.; width, 7.

Locality.—Gulf of Mexico, in lat. 28° 44′ N., long. 85° 16′ W., 60 fathoms, gray sand, station 2404, one male (No. 18157, U. S. N. M.).

Family CANCRIDÆ.

ACTÆA PALMERI, new species.

Carapace covered with 36 large, nodose prominences separated by deep sinuses filled with long silky hair, which also conceals the posterior portion of the carapace as well as the entire lower surface of the crab. The nodules of the surface are very convex and are each composed of a number of smooth, shining, bead-like granules crowded close together. The frontal lobes or nodules are thick, with convex, entire margins, and are separated by a deep sulcus. There are 6 orbital nodules, one very small inner-orbital, followed by 1 large and 2 small, and 2 suborbital nodules. The basal antennal joint is also a thick, shining, compound nodule. The carapace has 4 nodules on the lateral margin which project upward and not outward, the margin itself being entire. A small median lobule is visible near the posterior margin.

Chelipeds with merus smooth and hairy, carpus with 6 nodules, and manus with 5, the remainder of the surface silky-hairy. Immovable finger and distal half of dactylus smooth and shining, horn-colored, with white tips. The fingers are broad, compressed and sharp-pointed. The ambulatory legs have 2 small nodules on the carpal joints, 1 or 2 on the propodal joints, and 2 on the meral joints of the last pair.

Measurements.—Length of male, 16 mm.; width, 21. Length of female, 14; width, 19.

Locality.—Rodriguez Creek, Florida, Dr. Edward Palmer; 1 male, 1 female carrying a large quantity of minute eggs, and 2 young specimens, male and female (No. 13927, U. S. N. M.).

PILUMNUS DIOMEDEÆ, new species.

Carapace of moderate width, beset with long yellow hairs arising from low spinules. Front with 2 produced lobes, each bearing 4 slender spines; a longer incurved spine is placed near the antenna. Orbital spines 9, 2 on the upper margin, 1 at the outer angle, and 6 below. Of the suborbital spines, the 2 outermost are separated by a deep fissure. There are 4 strong antero-lateral spines, including the orbital; between the first and second there is a small spine, and the second

spine has 1 or 2 accessory spinules. The subhepatic and pterygostomian regions are spinulous. There are 2 small spines forming a longitudinal line with the inner suborbital spine.

Chelipeds unequal, spinous and long-hairy. Merus with surface minutely spinulous, margins spinous, the upper margin furnished distally with 2 spines longer than the others. Carpus with outer surface spinous and spinulous, a strong spine at the inner angle. Manus with 4 slender spines on upper margin, lower margin spinulous, spines of outer surface arranged in longitudinal rows, inner surface minutely granulous. Fingers spinulous and hairy proximally, horn-colored, with teeth and tips almost white. Ambulatory legs very long, slender and hairy; margins of meral joints and upper margin of carpal and propodal joints spinous.

The type specimen has the posterior portion of the carapace and sternum broken off and is without the last 3 pairs of legs. The only other individual is a soft-shell female, very imperfect.

Measurements.—Width of carapace, 16 mm.; width of front, 6; length of longest hairs of carapace, about 6.

Localities.—Off Havana, Cuba, in lat. 23° 10′ 40″ N., long. 82° 20′ 15″ W., 184 fathoms, fine gray and white coral, station 2345, type (No. 9526, U. S. N. M.). Off Yucatan, lat. 20° 59′ 30″ N., long. 86° 23′ 45″ W., 130 fathoms, coral, station 2354 (No. 18158, U. S. N. M.).

This species in its long ambulatory legs resembles *P. gracilipes*, A. Milne-Edwards, which differs, according to that writer, in its unarmed superior orbital margin and short hair.

THE FORMATION OF SANDSTONE CONCRETIONS.

By George P. Merrill,
Curator of the Department of Geology.

Many an interesting and instructive lesson in geological processes is frequently to be gained by observation of what is going on almost at our doors, but which is overlooked by the amateur because his attention has never been properly directed to it, and perhaps by the professional as well, because, as is so frequently the case, he is more interested in larger problems at a distance.

Such a lesson may be learned from the study of the globular and irregular rounded masses or concretions of ferruginous sand, sometimes quite hollow, or again partially filled with loose sand which falls out when the concretion is broken, leaving but the empty, deeply convex shells. As to what these are and what their method of formation may be, one may consult his geology long and in vain for a satisfactory solution.

The abandoned reservoir for the waterworks extension near Howard University, in Washington, D. C., furnishes in all its details so plain and interesting an explanation that he who runs may read, and I am tempted to describe it in detail even at the risk of wearying those to whom the illustration is neither new or needed.

The excavation above noted was made in the so-called Potomac division of the Cretaceous, consisting here of rather loose beds of sand and gravel, containing not infrequently fossilized logs of considerable size, both silicified and in the partially carbonized state known as lignite. It is with the last, only, that we have to do here.

In close contact with these lignites, either in the form of rounded and irregular nodular masses or as veins in the mass itself, are numerous globular aggregates of siliceous sand and iron disulphide in the form known as marcasite. (See figs. 1, 2, 3, and 4 of Pl. VI). So long as protected from atmospheric influences, such seem to have preserved their mineralogical identity fairly well. When disturbed, however, either in the work of excavation or through other means, so as

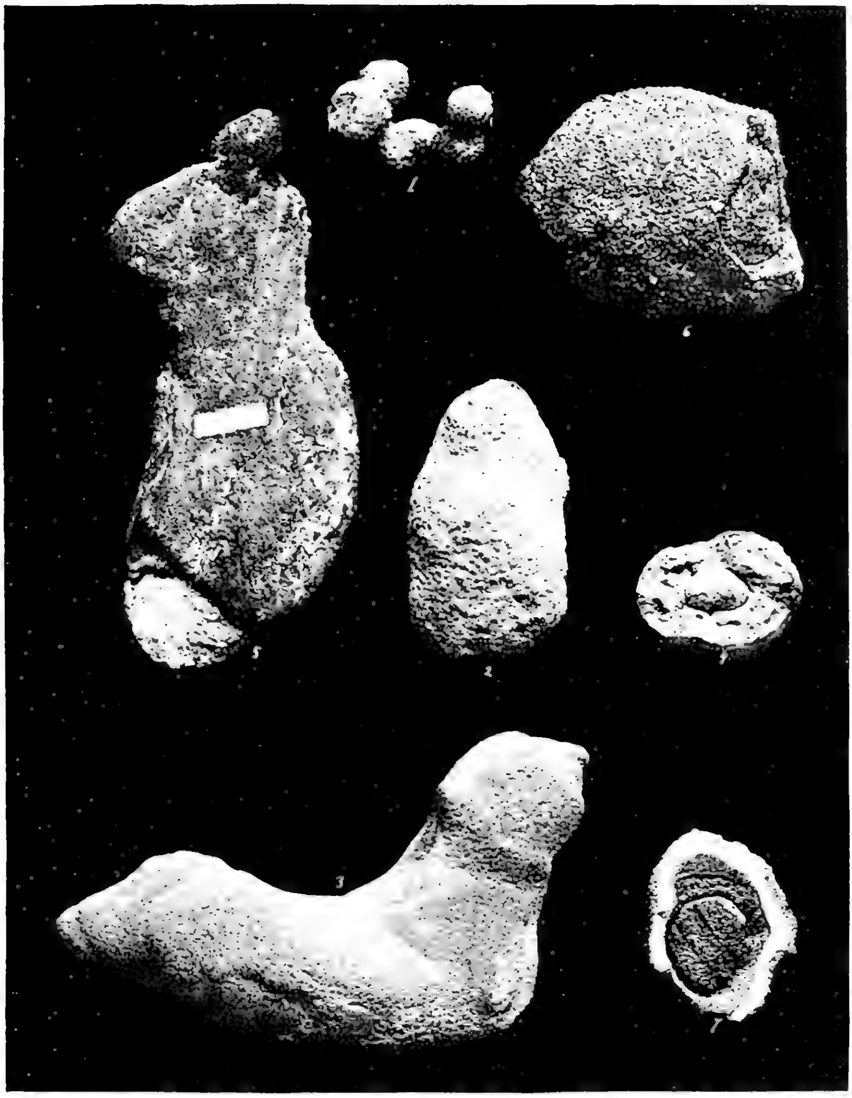
to be attacked by atmospheric agencies, they have undergone rapid decomposition. When lying on the immediate surface this decomposition (so far as the sulphide is concerned) consists mainly in the production of sulphates which are rapidly removed in solution, or which during the dry part of the year accumulate in the form of a thin, sulphur-yellow coating on the surrounding surface. When, however, buried in the loose siliceous sand the result is noticeably different. Here, owing presumably to an insufficient supply of sulphuric acid, a considerable portion of the sulphide passes into the condition of sesquioxide, which segregates in a narrow zone about the nucleal pyrite, cementing together the granules of siliceous sand and forming a crust or shell-like coating which is often quite dense and hard. All stages of the process are to be found, from those in which there is merely a thin crust of oxide (figs. 5 and 6) to those in which the sulphide has nearly disappeared (fig. 7). As the original concretionary mass rarely consisted of pure pyrite, but inclosed more or less sandy material, this last becomes liberated and not infrequently remains as loose sand partially filling the geode-like cavity.

The chemical processes involved in this change are presumably simple, though as we do not know for a certainty the exact conditions attending either solution or precipitation we can not be expected to describe them in detail. On the assumption that the iron was originally in solution as a ferrous sulphate, we can readily account for the presence of the pyrite concretions through the reducing action of gases given off by the decomposing wood. If, however, the iron existed, as at first seemed more probable, as a ferrous carbonate, the precipitation is less readily accounted for, since it seems doubtful if the small amount of sulphuretted hydrogen liberated would be sufficient for the production of so large a quantity of pyrite as is here found.

EXPLANATION OF PLATE VI.

Figs. 1, 2, 3 and 4. Characteristic forms of concretions formed of granules of siliceous sand cemented by marcasite. In fig. 4, there has been internal shrinkage, causing cracks suggestive of an intermediate stage in the formation of septaria.

Figs. 5, 6 and 7. Nodules showing stages of oxidation. In fig. 5, the oxidation has barely commenced, giving a red brown coating perhaps one-eighth inch thick on the outer surface. This coating has been removed from the lower end, exposing the marcasite. In fig. 6, the nucleal mass carries so much sand as to be distinctly granular, but the line of demarkation between the oxidized and unoxidized portion is plainly evident. In fig. 7, the loose sand fell away in process of cutting, leaving the unoxidized portion as shown.



Concretions of Marcasite and Siliceous Sand.

MONOGRAPH OF THE GENUS GNATHODON, GRAY (RANGIA, DESMOULINS).

[With plate VII.]

By WM. H. DALL,

Honorary Curator of the Department of Mollusks.

THE genus *Gnathodon* is one of those in regard to which much interest attaches, on account of its disputed place in the systems, its uncertain nomenclature, and its zoological peculiarities. In working up the Tertiary species it became necessary to review the whole group and investigate its relations afresh with newly collected material. Out of these researches, among other results, has grown the present monograph, which is believed to settle the systematic position and nomenclature of the genus.

Genus GNATHODON, Gray.

Gnathodon (GRAY *MS.*), SOWERBY, Gen. Sh. No. 36, Dec. 1831 (Type *G. cuneatus* Gray).—GRAY, P. Z. S. 1836, p. 101.—GRAY, Loudon's Mag. Nat. Hist. I, n. s., p. 376, 1838.—CONRAD, Medial Tert. No. 1, p. 23, 1838.—ANTON, Verz. Conch., p. 10, 1839.—SBY, Man. Conch., fig. 83, 1839.—CONRAD, Medial Tert., No. 2, p. 69, 1840.—SWAINSON, Malac., p. 370, 1840.—CONRAD, Am. Journ. Sci., XXXVIII, p. 92, 1840.—REEVE, Conch. Syst. I, p. 62, pl. 43, 1841.—CONRAD, 2d Bull. Nat. Inst., pp. 190, 192, 1842.—DEKAY, Moll. N. York, p. 233, 1843.—HANLEY, Descr. Cat. Rec. Sh., p. 35, pl. 10, fig. 22, 1843.—POTIEZ & MICH., Gal. de Douai, II, p. 194, 1844.—GRAY, Gen. Moll. P. Z. S., 1847, p. 186.—PHILIPPI, Handbuch Conch., p. 317, 1853.—WOODWARD, Man., ed. I, p. 308, 1856.—DALL, Bull. 37, U. S. Nat. Mus., p. 62, 1889.

Rangia, DESMOULINS, Actes Soc. Lin. de Bordeaux, V, No. 25, p. 50, Feb. 15, 1832 (Type *R. cyrenoides* Desm.).—CONRAD, Am. Mar. Conch., p. 56, 1833.—H. & A. ADAMS, Gen. Rec. Moll. II, p. 380, 1856.—CONRAD, Proc. Acad. Nat. Sci., Phila., 1860, p. 232, 1861.—CONRAD, Medial Tert. Index, p. 88, 1861.—PRIME, Proc. Bost. Soc. Nat. Hist. VII, p. 347, 1861.—CONRAD, Am. Journ. Conch. III, suppl., p. 30, 1868.—FISCHER, Man. de Conchyl., p. 1095, 1887.

Gnatodon, RANG, Nouv. Ann. du Muséum, III, p. 217, 1834.

Columbia (BLAINVILLE *MS.*), RANG, *op. cit.*, p. 217, 1834.

Clathradon (GRAY *MS.*), CONRAD, Am. Journ. Sci., XXIII, p. 340, Jan., 1833. *Lapsus* for *Clathrodon*, Gray *MS.*, 1830.

Clathodon, SOWERBY, Man., 2d ed., p. 108, 1842.

Perissodon, CONRAD, Proc. Acad. Nat. Sci., Phila., 1862, p. 573, 1863 (Type *P. Grayi*, CONRAD=*Mactra clathrodonta*, CONRAD, 1833).

Rangianella, CONRAD, Am. Journ. Conch. III, suppl., p. 30, 1867 (Type *G. trigonum*, PETIT, Mazatlan, Mexico).

Shell trigonal, equivalve, closing completely; umbones prominent, not adjacent, smooth at the point of origin, erect or twisted forward; lunule and escutcheon obscure or absent; shell-substance porcelain-white internally; externally chalky, with a thin epidermis; anterior shorter than the posterior end; the latter produced or rostrate; hinge comprising a bifid triangular cardinal tooth in one valve over which fit two lamellar divergent teeth of the opposite valve, an accessory lamella sometimes rising from the anterior edge of the cartilage pit next the cardinals; an anterior lateral tooth in one valve received between two less prominent laminæ of the opposite valve, of which pair the dorsal lamina approaches nearer the cardinal tooth than the ventral one, leaving a gap into which the proximal end of the anterior lateral, when adult, is more or less distinctly hooked; a longer posterior lateral in the same valve as the anterior tooth, received between two subequal less prominent laminæ in the opposite valve; teeth crenulated or granulose on their opposed surfaces; cartilage pit deep, persistent; internal border of the valves smooth or faintly radiately striated; adductor scars distinct, the anterior smaller; pallial line distinct, distant from the margin; pallial sinus small, rather irregular; cartilage large, inserted on the ventral surface of the pit, persistent in its entirety, so that its distal ends sometimes project from the eroded umbones; ligament wholly internal, small, inserted on the dorso-posterior surface of the pit and separated by a shelly ridge on each side from the cartilage below it; mantle-edge smooth, simple, the lobes marginated, the inner edge of the margin thicker and elevated, the lobes free edged from below the anterior adductor nearly to the siphons; antesiphonal channel of the incurrent siphon longitudinally divided by an elevated raphe arising from the inner surface of the mantle; siphons moderate, united to their tips, their distal orifices sparsely papillose; the proximal orifice of the incurrent siphon with an imperfect arched valve; gills two on each side, the inner larger, suspended by its base; the outer smaller, its line of attachment crossing the gill obliquely and forming of the upper portion an "appendix" which is soldered to the mantle by most of its dorsal surface; all four gills united behind the foot, their proximal portion forming a septum which is anchored to the anterior portion of the siphonal septum, thus completely separating the anal and peripedal chambers; palpi, four in number, narrow, long, internally striated, externally smooth, the lower pair continuous medially in front of the foot; foot small, compressed, short, angular in front, pointed behind, ventral edge sharp, entire; byssus and byssal gland atrophied or absent in the adult.

Distribution.—Subtropical America, the Gulfs of California and Mexico in shoal quiet water varying from salt to fresh, but preferably somewhat brackish, as in the case of oysters; range in time from the newer miocene to recent seas.

The genus falls naturally into three sections, the typical group best illustrated by *G. cuneatus;* a second, *Miorangia*, Dall, represented by the miocene *G. Johnsoni*, a very small, extremely inequilateral type with obsolete pallial sinus and the cardinals reversed, the superior pair being in the left valve; the other, named *Rangianella* by Conrad, being characterized by subequal faintly rugose lateral teeth, an obsolete pallial sinus, and a more equilateral elongate and smaller shell.

The subgenus *Rangianella* forms the transition toward *Mulinia*, and some of its species can only be distinguished from species of *Mulinia* by the smaller pallial sinus and the inconspicuous "hook" on the proximal end of the anterior lateral tooth. A number of small species of *Mulinia* have been described under the name of *Rangia* or *Gnathodon*, so close is the relation between them. Several species of *Mulinia*, if not all of them, are denizens of brackish water, and to errors based on these facts are due the statements which have represented *Gnathodon* as being extra-American in distribution.

As far as I have been able to judge from the specimens I have seen, the species described will be assorted as follows:

A: *Gnathodon;* typical group; *G. cuneatus* Gray, *G. clathrodon* Conrad, *G. Grayi* Conrad, *G. Lecontei* Conrad, *G. minor* Conrad.

B: *Miorangia*; *G. Johnsoni* Dall.

C: *Rangianella; G. flexuosus* Conrad, *G. rostratus* Petit, *G. trigonus* Petit, *G. mendicus* Gould.

The other species hitherto described may be referred to *Mulinia*, *Isocardia*, and other groups external to the genus as properly restricted.

This genus has had singular nomenclatorial vicissitudes. The type species was well known to the early conchologists of the United States, and was regarded by them as identical with the problematical fossil named by Lamarck *Cyrena truncata*. Gray, from a ballast heap left in Canada by a vessel from the Gulf of Mexico, received two valves, which he described under the name of *Clathrodon*, and sent the manuscript to the editors of the American Journal of Science, to be published in America, about 1830. Believing it to be the same as Lamarck's species, the editors suppressed Gray's description. Later Gray substituted *Gnathodon* for the ill-constructed name *Clathrodon*, and the former was published by Sowerby in his "Genera of Mollusca," Part XXXVI. This was the first publication of the name *Gnathodon*, and appears to have been made in the last quarter of the year 1831,* the number containing

* *See* Newton, Brit. Oligocene and Eocene Moll., p. 321, 1891. Since writing this note the researches of Mr. C. Davies Sherborne, kindly undertaken at my suggestion, show that No. XXXVI was received and entered on the donation book of the Linnean Society, London, January 4, 1832; from which it may be inferred that the number in question was printed in the last days of December, 1831.

it having references in it to the number of the Zoological Journal published September, 1831. In December, 1831, Desmoulins read to the Linnean Society of Bordeaux a paper published by that Society February 15, 1832, containing an excellent figure and account of the species under the name of *Rangia cyrenoides*, which name was adopted by Conrad in his American Marine Conchology, who at the same time mentioned the earlier unpublished *Clathrodon* of Gray. The "Genera" of Sowerby and Conrad's Marine Conchology were both rather obscure publications, the dates of several parts of which are difficult to discover, and both the authors, Gray and Conrad, appear to have forgotten about these early publications. The former in 1847 gives the date of his *Gnathodon* as "1837," which is possibly a misprint for 1831. Conrad in 1832 adopted *Rangia;* in 1833 he was disposed to revive Gray's manuscript name of *Clathrodon* on the ground of courtesy; in 1834 Rang seems to have no doubt that the name *Gnathodon* had been published before Desmoulins's *Rangia*, and adopts the former. In 1838 Conrad adopts *Gnathodon*, and uses it again in 1840. In 1860 he reverts to *Rangia*, and continues to use it in 1863, when he proposes a subgeneric name, *Perissodon*, for the fossil *R. Grayi*, and in 1868 another subgeneric name, *Rangianella*, for a Pacific species. The latter of these names was defined. It may be noted that *Gnathodon* was employed by Jardine for a genus of birds in 1845, and *Rangia* by Agassiz, in 1860, for a genus of Cœlenterates. The name *Gnathodon* is masculine, and the specific names should take a masculine termination. Monographic lists of the genus have been printed by Conrad (Proc. Acad. Nat. Sci. Phila. for 1860, p. 232); Prime (Proc. Boston Soc. N. Hist., VII, p. 347, 1861); Fischer (Journ. de Conch., IX, p. 212, 1861); Conrad (Am. Journ. Conch., III, Suppl. Cat. of *Mactridæ*, p. 30, 1868); and Reeve (Conch. Icon., XIX, 1873). Singularly enough, neither of these authors has given the synonymy of the generic name correctly. The date of 1831, when Desmoulins's paper was read, is assigned to *Rangia*, which, however, was not published until February, 1832. The date of 1831 is assigned to Conrad's mention of the genus in his American Marine Conchology, though he adopts *Rangia*, which was not published until 1832, and it is highly probable that the part of Conrad's work containing *Rangia* did not appear until 1833, since it was contained in the fifth fasciculus, and the third fasciculus is dated May, 1832. At all events it can not be earlier than the latter part of 1832. Gray's manuscript name of *Clathrodon* was never formally proposed in print, and Conrad's earliest mention of it is in 1833.

Gray and Desmoulins both referred the genus to the *Mactridæ*, while pointing out that in certain features it recalled *Cyrenidæ*. This view has generally prevailed, though lately Dr. Paul Fischer concluded (Manual, p. 1095) that it is more nearly related to *Cyrena*. Rang's notes on the anatomy were probably made on defective material; at all events, they contain several errors which tend to obscure the mactroid affini-

ties of the shell. Dr. Fischer also raised the group to family rank, which, if it be compared solely with *Cyrenidæ*, is reasonable, but, if the comparison is with the *Mactridæ*, and sufficiently full material is consulted, it will be seen that there are really no characters which remain after the characters common to Mactras and Mulinias are excluded, upon which even a subfamily can be based. The distinctive characters of the genera of the *Mactridæ* merge so gradually from one form into another that we are forced to the opinion that Gray and Desmoulins were right, and that the group can only be ranked as a genus, next to *Mulinia*, in the Mactroid series.

In the endeavor to come to a well-founded conclusion in regard to the affinities of *Gnathodon*, a careful examination was made of the soft parts of *G. cuneatus* from Mobile and Texas; *Mactra (Spisula) similis*, Say, Florida; *M. (S.) polynyma* Stm., Alaska; *M. (Mulinia) lateralis* Say, Massachusetts; *Cyrena carolinensis* and *Cyrena floridana* Conrad, from Florida. I received half a dozen Gnathodons from Mobile Bay alive, by mail, through the kind intervention of Mr. G. D. Harris; and others, in alcohol, from Port Lavaca, Texas, from Mr. J. D. Mitchell. Several errors were found in Rang's account of the macroscopic anatomy, leading to the suspicion that he dealt with specimens which had already been removed from the shell when he received them. The following notes were made from the specimens:

The foot of *Gnathodon cuneatus* is like that of *Mactra*, but shorter and more compressed. There is no external indication of a byssal gland. The retractor muscle of the foot on each side is attached to the underside of the cardinal border above and near the adductor.

The siphons of *Gnathodon* are short, but united to the ends, as in *Mactra*. The incurrent siphon is papillose at its orifice, the excurrent siphon smooth-edged, or very finely papillose, differing in different specimens. The external surface of the siphons is of a dark olive color, nearly black where most intense, with a lighter line conforming to the intersection of the vertical plane between the valves with the siphonal commissure. The mantle-margin is wide and smooth, the distal edge thin, blending with the papery epidermis, the inner edge thick, smooth, and somewhat elevated. The anterior commissure is in front of the adductor, thence backward the lobes are separated three-fourths of the way to the siphons, much as in *Mactra*. A short distance within the margin, beginning in the posterior half of the shell and extending backwards to a point under the shade of the valve of the incurrent siphon is an elevated raphe of tissue which divides the incurrent channel. A similar arrangement is found in *Mactra*, but not in *Cyrena*. This ridge is probably the seat of sensory tissue analogous to the osphradium of Gastropods.

The palps are triangular, slender, rather long, the lower ones extending to the posterior fourth of the foot on each side, continuous below the mouth, where they are soldered to the visceral mass, and joined

above with the inner anterior edges of the somewhat shorter upper pair. The inner surfaces of both are striated, the outer surfaces smooth. Rang indicates the mouth below the lower palps, which is obviously erroneous.

The gills are of moderate size, two on each side, the inner pair larger, and hung by their upper edges from the visceral mass. The attachment of the outer pair is about a millimeter higher, separated from the suture of the inner gills by a fine very tender membrane; the line of attachment divides the outer gill at its upper third, the upper portion is more or less fixed upon the mantle by slender adhesions toward its middle third, and bent downward, but is more free before and behind. This reflected portion of the outer gill is what is often referred to as the "appendix." Both gills are joined by a delicate membrane behind the *retractor pedis* (where the width of the two gills is approximately equal) to each other, to the pair of the opposite side and to the siphonal septum, forming a complete partition between the anal and peripedal chambers. This is also found in the various forms of *Mactra* examined and in *Cyrena floridana*, though in the latter the attachments are extremely delicate. Below the septum in *Gnathodon* a thin arched membrane forms an imperfect valve at the base of the incurrent siphon, as in *Mactra*, but in *Cyrena* this was hardly perceptible. The whole surface of the gills is finely striated, of a dull cream color, vertically barred with about twenty dark brown transverse lines. In all the other species examined the gills were colorless. In Rang's figure the anal and peripedal chambers are wrongly represented as communicating behind the gills, which error was doubtless due to rupture of the membranes.

So far as the soft parts are concerned, it will be seen from the preceding notes that *Gnathodon*, *Mactra*, and *Cyrena* agree essentially in the general structure and attachments of the gills, in having a separate anal chamber, in the general form of the foot (shortest in *Cyrena* and longest in *Mactra*), in the separation of the mantle lobes (somewhat greater in *Cyrena*), and in the absence of a byssus.

Gnathodon agrees with *Mactra* in having the siphons united to their ends and the incurrent one furnished with an imperfect basal valve and with an elevated raphe behind it. It agrees with the *Mactridæ* in having an internal cartilage and with *Mulinia* in having both the (ordinarily external) ligament and cartilage internal and contained in the same socket. In all these features *Mactra* and *Gnathodon* differ from *Cyrena* and its allies, all of which have only an external ligament set in a groove and separated by an elongated fulcrum, or nympha, from the cardinal border.

In considering the evidence of the harder parts all the species of *Gnathodon* must be examined, the typical species being more extreme in its characters than any of the others. It is also necessary to examine very young specimens, which are extremely difficult to get hold of, notwithstanding the abundance of the species on the Gulf coast.

My much regretted friend, the late Dr. Paul Fischer, in his Manual has compared *Rangia* to a *Cyrena* with an internal cartilage, and has regarded the cardinal teeth of the former as alternating, or *Heterodont*, and those of *Mactra* as of the type which has been called *Desmodont* by Neumayr. For these reasons he placed his family *Rangiidæ* immediately after *Cyrenidæ* in the Manual. If he had been able to study the series which has been available for me I can not doubt he would have changed this opinion. A study of the young shows that the hinge of *Gnathodon* in its early stages is as typically Desmodont as that of *Mactra* and that the truncation of the ᴧ-shaped teeth is a dynamic feature due to the exigencies of growth, which may be observed in *Mulinia* as well as *Gnathodon*. As a matter of fact neither *Mactra* nor *Gnathodon* has genuine Desmodont dentition. The hinges of both are really Heterodont.

In the young *Gnathodon cuneatus* 10 mm. long, the hinge possesses the following armature:

Left valve: Anterior lateral tooth slender, slightly arched, crenulate above, behind without the characteristic hook from which Gray derived his name for the genus; cardinal tooth thick, ᴧ-shaped, with a pronounced depression on each side of it; anterior border of the cartilage-pit with a small accessory lamella; the upper part of the anterior border showing a small blunt projection corresponding to the hiatus between the cartilage and the ligament above; this is probably a relic of the shelly bridge which roofed the pit before the ligament descended into it; pit deep, its ventral border projecting as in *Mactra;* the insertion scars of ligament above and cartilage below entirely separate, with a small shelly ridge rising between them; posterior lateral long, thin, slender, arched, crenulate above.

Right valve: Furrow for the anterior lateral tooth narrow, crenulate on both sides, the lamina below it not much thickened; cardinal teeth two simple lamellæ closely approximated (but not joined) at their upper ends, with a ᴧ-shaped pit below them, into which is received the cardinal tooth of the opposite valve; (this arrangement is exactly paralleled in *Mulinia lateralis*); posterior groove for the lateral of the left valve narrow, crenulate on both sides; the lower lamina slightly more prominent than the upper one; other features as in the left valve.

At this stage the pallial sinus is proportionally larger and rounded anteriorly as in *Mactra*, in short all the distinctive characters of the young shell, in which it differs from the adult, are Mactroid.

Looked at from the standpoint of dynamic evolution, the hinge of this group and the other *Mactridæ* in its development offers much that is of interest. The various stages of immersion of the ligament in the different genera and subgenera illustrate well the manner in which it has been ingulfed. So too the changes between the juvenile hinge and that of the full-grown adult when regarded from a dynamic standpoint are more easy of explanation than from any other point of view.

Gnathodon seems to be indifferent as to the salinity of the water in which it lives, as it is found both in the sea outside of the lagoons and in the brackish water of the lagoons, while the living specimens received by me from Mobile Bay seemed to maintain perfect health for some four or five days in perfectly pure fresh water. But there is no doubt that it is, by preference, like the oyster, an inhabitant of waters the salinity of which has been diluted by their proximity to the mouths of rivers or creeks. In common with the majority of pelecypods inhabiting fresh or brackish water, it has acquired the habit of secreting a very heavy shell which is almost always eroded a good deal by the free carbon dioxide of such locations.

The peculiar hooked or jaw-shaped anterior lateral, which, in connection with the longer posterior lateral, is the most marked characteristic of the genus, results from the inequality of the two laminæ between which it is inserted in the opposite valve. In *Mulinia* (from which *Gnathodon* seems to be an off-shoot) the laminæ and teeth are alike short and somewhat removed from the vicinity of the cardinal teeth. In *Gnathodon*, however, the laminæ are prolonged until they are very close to the cartilage pit behind and to the cardinal teeth in front. The lower anterior lamina, for some unknown reason, did not attain the same length and there is a gap between the cardinal tooth and the end of the lower lamina. In *Gnathodon*, as in other pelecypods, the surface of the mantle is produced in such a way as to secrete and deposit the shelly matter demanded by the growth of the hinge. The ventral exposures of the hinge and its laminæ are those upon which deposition is most profuse and direct, consequently the gap referred to was rapidly filled by deposition from below on the ventral face of the projecting part of the upper lamina. The process may be seen in its successive stages in any good series of *Gnathodon cuneatus*. Once the "hook" is formed, it molds to a greater or less extent the form of the tooth impinging upon it, and is preserved, among other reasons, because the triangular buttress which it finally becomes is the most efficient obstacle which the hinge possesses to the rotation of the valves on the cartilage as a center. The tendency to this rotation, potentially very injurious, has been promoted by the degeneration and immersion of the ligament. Consequently it is not at all improbable that the "hook" is a character which would be enlarged and preserved by natural selection. The oldest species (*clathrodon*) has it least developed, the most abundant recent species (*cuneatus*) most so. It is distinctly present in all the known species, but not always conspicuous. In the adult the efficient action of the hinge is promoted by distinct, usually transverse, crenulations on opposed surfaces. Where the surfaces are flat the crenulations are usually parallel grooves, but on rounded surfaces, such as the point of the lower anterior lamina in the right valve, they may be wavy, granular, or irregular. The end they serve is that of decreasing the tendency to any wobbling of the hinge, and these crenulæ are

merely the result of the same processes which developed the original hinge teeth in the prionodont section of the Paleopelecypoda. Where the motion is purely to and fro, giving rectilinear friction of the opposed surfaces, the rugæ must be parallel and regular, corresponding to the direction of the movement. Where the motion may be slightly irregular, corresponding irregularities will appear in the rugosities. The tendency of the development of rugæ is to confine and limit the range of motion in the interest of the safety of the mollusk, a tendency which culminates in the interlocking rigid hinge of *Plicatula* and *Spondylus*. Contrary to the supposition of Neumayr, I believe there is no fundamental distinction between the groups possessing Desmodont and Heterodont hinge teeth, but that both are developed according to the particular circumstances of the case; the immersion of the ligament and development of a cartilage may occur in some genera of any natural group.

Typical species.

GNATHODON CUNEATUS, Gray.

Plate VII, figs. 1 and 10.

Gnathodon cuneatus, GRAY, SOWERBY, Genera of Sh., Part XXXVI, figs. 1–3, 1831.—GRAY, P. Z. S. 1836, p. 104; Loudon's Mag. N. H., n. s., 1, p. 376, fig. 34, 1838.—CONRAD, Medial Tertiary, No. 1, p. 23, 1838.—ANTON, Verz. Conch., p. 10, 1839.—SOWERBY, Man. Conch., 1st ed., fig. 83, 1839; 2nd ed., p. 154, fig. 83, 1842.—SWAINSON, Malac., p. 370, 1840.—REEVE, Conch. Syst., I, p. 62, pl. 43, 1841.—CONRAD, 2nd Bull. Nat. Inst., pp. 190, 192, 1842.—DE KAY, Zool. N. York, Moll., p. 233, pl. 25, fig. 267, 1843.—HANLEY, Descr. Cat. Rec. Sh., p. 35, pl. 10, fig. 22, 1843.—GRAY, Gen. Moll. P. Z. S. 1847, p. 186.—PHILIPPI, Handb. Conch., p. 317, 1853.—HOLMES, Post Pl. Fos. S. Car., p. 41, Pl. VII, fig. 10, 1860.—DALL, Bull. 37, U. S. Nat. Mus., p. 62, 1889.

Rangia cyrenoides, DESMOULINS, Actes Soc. Lin. de Bordeaux, V., p. 57, figs. 1–3, Feb. 15, 1832.—CONRAD, Am. Marine Conch. pp. 56, 57, Pl. XIII, 1832.—H. & A. Adams. Gen. Rec. Moll., II, p. 380, Pl. 100, figs. 4, 4*a*, 1856.—CONRAD, Proc. Acad. N. Sci. Phila. 1860, p. 232, 1861; Medial Tert. U. S., Index, p. 88, 1861.—Prime, Proc. Bost. Soc. N. H., VII, p. 347, 1861.—CONRAD, Am. Journ. Conch., III, app., p. 30, Cat. *Mactridæ*, 1868.—FISCHER, Man. de Conchyl., p. 1096, Pl. XXI, fig. 2, 1887.

Gnathodon Grayi, TUOMEY & HOLMES, Pleioc. Fos. S. Car., p. 99, pl. 23, fig. 11, 1857; not of Conrad; *Ibid.*, Post Pl. Fos., p. 41, 1860.

Gnathodon minor, HOLMES, Post Pl. Fos. S. Car., p. 41, 1860; in synonymy.

Clathradon cuneata, (GRAY *Ms.*) CONRAD, Am. Marine Conch., p. 57, 1833; Am. Journ. Sci., 1st ser., XXIII, p. 340, 1833.

Pliocene of the Carolinas and of Florida (Caloosahatchee beds). Pleistocene of Cornfield Harbor, Chesapeake Bay, and Wailes' Bluff, Potomac River; of South Carolina; of Florida; of the whole north coast of the Gulf of Mexico and on the north coast of South America (?), Lea; Pleistocene (?) of Matamoras, Mexico, Dugés; Living in Mobile Bay, Alabama, and westward on the north shore of the Gulf to Vera Cruz, Mexico, in shallow water, either brackish or perfectly salt. I have re-

ceived from Mr. J. D. Mitchell, of Texas, a living specimen upon which an oyster, at least two years old, and several specimens of *Mytilus hamatus* were firmly attached.

Details in regard to this species will be found under the discussion of the genus. I am informed that on the Texas coast it has been extensively preserved for food in cans under the name of "Little Neck Clams," and has met with some favor, gastronomically.

The dimensions of an adult specimen are as follows: Length 75, height 60, diameter 50 mm.; but the proportions vary somewhat with the amount of rostration of the individual.

The epidermis of *G. cuneatus* is normally of an ashy gray color, sometimes with a tinge of greenish or brownish, and of a papery consistency. When worn it has a more brownish tint, and some specimens display streaks of a light ferruginous brown when the epidermis is thick and worn. There is sometimes shown a smoother and more translucent area of epidermis in the region where the lunule and escutcheon of bivalves usually occur, though these areas are not set off by any groove; but they are chiefly visible in adolescent specimens and often absent entirely. Toward the posterior end of the shell the epidermis is often raised in fine wrinkles, and it is usually more or less eroded on the beaks. The sculpture of the exterior of the valves is chiefly incremental and irregular, but many specimens show traces of radiating raised threads, especially in the rostral region. A wide obscure depression extending from the beaks to the margin and, with the valves closed, circumscribing a cordate area, is visible on the anterior end of many specimens. It corresponds nearly to the lower part of the anterior adductor scars within the valves. No umbonal sculpture like that of many unios can be observed on the uneroded beaks. They are always smooth, as in *Mactra*.

In common with most brackish water shells this species has a considerable range of variability in form. In this case it chiefly arises from a difference in the height of the umbones, and especially from the shape of the posterior extreme of the shell, which normally is somewhat produced and evenly rounded at the margin, but in other cases is somewhat rostrated, with the basal margin somewhat concavely flexuous. This is carried to an extreme in a variety which may be called

GNATHODON CUNEATUS var. NASUTUS, Dall.

Plate VII, fig. 8.

In salt water at Port Lavaca, Texas, Mitchell.

Length 35, height 27, diameter 24 mm., in the typical specimen. This form was found by Mr. Mitchell, with others of the typical character, in pure salt water on the Texas coast. The specimen is small compared with the adult of the type form, but seems mature and is quite thick. It has nearly the form of *G. flexuosus*, but can at once be

discriminated from the latter by the presence of a deep though small pallial sinus and a long, arched, posterior lateral tooth.

GNATHODON CLATHRODON, Conrad (emended).

Plate VII, fig. 9.

Mactra clathrodonta, CONRAD, Am. Journ. Sci., 1st ser., XXIII, p. 340, 1833.

Gnathodon grayi, CONRAD, Medial Tert., p. 23, pl. 13, fig. 1, 1838; *Ibid.*, second ed. by Dall, 1893.—EMMONS, Geol. Rep. N. Car., p. 298, fig. 226*a*, 1858.

Gnathodon minor, CONRAD, Medial Tert., p. 69, pl. 39, fig. 6, May, 1840 (Testa junior). Am. Journ. Sci., 1st ser., XLI, p. 347, pl. 2, fig. 14, Oct., 1841. Not of Whitfield.

Rangia minor, CONRAD, Proc. Acad. Nat. Sci. Phila., XII, p. 232, 1861.

Rangia clathrodonta, CONRAD, *op. cit.*, XII, p. 232, 1861.—PRIME, Proc. Bost. Soc. N. Hist., VII, p. 347, 1861.

Rangia (Perissodon) clathrodonta, CONRAD, Proc. Acad. Nat. Sci. for 1862, p. 573, 1863.—MEEK, Smithsonian Misc. Coll. 183, Checkl. Inv. Fos. Mioc. N. Am., p. 11, 1864.

Rangia (Perissodon) minor, CONRAD, Proc. Acad. Nat. Sci., Phila. for 1862, p. 573, 1863.—MEEK, Checklist, p. 11, 1864.

Chesapeake Miocene of James and York rivers, Virginia and North Carolina, Conrad, Ruffin, and Yarrow; Pliocene of the Croatan beds in North Carolina, Johnson.

The dimensions of an adult specimen are: Length, 70; height, 54.5; diameter, 40 mm.

This is the oldest species of the genus, and appears in the Chesapeake Miocene of Virginia, but seems to be very limited in its distribution. I have seen no specimens from south of North Carolina. It may be discriminated from *G. cuneatus* by its thinner and more compressed shell, its slender and straighter lateral teeth, its more shallow and open cartilage pit, its less prominent and more adjacent beaks. The pallial sinus is small but angular. The lateral teeth are crenulate, especially above; the posterior end of the shell, though not rostrate, is rather pointed.

A subgenus *Perissodon* proposed for this species by Conrad, but never defined, seems to have been based on the specific differences above referred to. There are certainly no features of more than specific value separating this form from *G. cuneatus*. I am quite confident that Conrad's *G. minor*, described from the same beds as *G. clathrodon*, is merely a young stage of the latter. Conrad's figure agrees with such young shells very well, and his description affords no differential characters.

GNATHODON LECONTEI, Conrad.

Plate VII, fig. 4.

Gnathodon Lecontei, CONRAD, Journ. Acad. Nat. Sci. Phila., 2d Ser., II, p. 273, pl. 24, figs. 1–3, Jan., 1853; Proc. Acad. Nat. Sci., VII, p. 31—GOULD, in Pac. R. R. Rep., V.; appendix, p. 230, 1855.

Rangia Lecontei, CONRAD., Proc. Acad. Nat. Sci. Phila. for 1860, p. 232, 1861.—MEEK, S. I. Checkl. foss. N. Am., Miocene, p. 11, 1864.

Fossil in the upper Tertiary (Pliocene?) rocks on Carisco Creek, Colorado desert, Arizona, Dr. Leconte. Type in the National Museum, Reg. No. 6833.

Length, 22 mm.; height, 20; diameter, 16.

This species, which is said to occur in great abundance at the locality mentioned, most nearly resembles *G. cuneatus* but is a more trigonal shell than specimens of *cuneatus* of the same length, has a smaller pallial sinus, and is a considerably smaller and less heavy species. There are also differences in the arrangement of teeth on the hinge line. It differs from *G. trigonus* Petit in having long lateral teeth and in being proportionately more elevated. The beaks are high and more closely adjacent than in *G. cuneatus.* Carpenter (Rep. Brit. Assoc. Moll. W. C. N. Am., 1863, p. 592) correctly distinguishes this species from *G. mendicus* or *trigonus*, and recognized its greater resemblance to the *G. cuneatus.* No specimens seem to have been collected by any one since Dr. Leconte, who described them as found in a layer of rock two feet thick in the bank of the creek, where they occurred in the greatest profusion. The small pallial sinus in this species is a step in the direction of *Rangianella.*

Section MIORANGIA, Dall.

GNATHODON JOHNSONI, Dall.

Plate VII, fig. 7.

Gnathodon Johnsoni, DALL, Science, Vol. XX, No. 502, p. 165, September 16, 1892 (name only); Trans. Wagner Inst. III, p. 337, pl, 22, fig. 18, December, 1892.

Venus mobiliana, JOHNSON, Science, Vol. XX, No. 501, p. 151, September 9, 1892 (name only).

Fossil in the Miocene of the Pascagoula clays at Shell Bluff, Pascagoula River, Greene County, Miss.; also at a depth of 700 feet in the artesian well at Biloxi, Miss., and of 735 feet in the artesian well at Mobile, Ala.; L. C. Johnson.

Shell small, rather compressed, ovate-triangular to submytiliform in outline, rather thin for the genus, externally smooth or marked only with lines of growth when perfectly normal, but frequently concentrically fluctuate owing to irregularities of growth; beaks prominent, compressed, anterior, close to the hinge line; margin of the shell entire, with no circumscribed lunule or escutcheon; interior smooth, muscular impressions small, distinct; pallial line with a shallow incurvation behind, hinge very asymmetrical, the anterior lateral tooth in the left

valve, short, Λ-shaped, received in the right valve into a corresponding sulcus, below which a triangular pustule represents the anterior lateral of that valve; cardinal teeth of the left valve diverging, lamellar, the anterior lamella situated above the anterior lateral tooth, fitting above a triangular cardinal tooth grooved or partly split at the apex, in the right valve; posterior lateral tooth in the left valve long, arched, finely crenate above, received in the right valve between two slender laminæ, of which the lower one is most prominent; pit for the ligament and cartilage narrow, oblique, roofed over by a very thin shelly layer generally worn off in rubbed specimens. Length of shell 17.5; height 1.15; double diameter of valve, 10 mm. Fragments indicate that the species reaches a length of at least 25 mm.

This species differs from the young of *G. cuneatus* in the fact that the Λ-shaped cardinal tooth is in the right valve when the valves are closed, while in *G. cuneatus* it is in the left valve, as well as in *clathrodon*, *Lecontei*, *mendicus* and *flexuosus*. In *G. Johnsoni* the anterior lateral tooth is shorter, relatively, than in any other species, and the shell is more drawn out behind the beaks.

The geological age of this species is somewhat in doubt. It is associated with *Hydrobia mobiliana* Dall, and with a large oyster and *Mulinia lateralis* var. *corbuloides* Reeve. The latter is a living species and is not otherwise known below the newer zones of the Chesapeake Miocene. The Pascagoula clays were referred to the Grand Gulf beds by Hilgard, and overlie them. There is no doubt that the typical Grand Gulf beds are included between the Hawthorne beds, at the base of the older Miocene, and certain beds of the Chipola series; at present it seems improbable that the Pascagoula clays can be correlated with anything older than the Chesapeake. I am disposed to consider them as corresponding to the aluminous clay above the Chesapeake clay-marl in the Alum Bluff series.

Subgenus RANGIANELLA, Conrad.

Rangianella, CONRAD, Am. Journ. Conch., III, Suppl. p. 30, 1867.
Rangia, CARPENTER, Mazatlan Shells, p. 53, 1857.

Lateral teeth short, subequal, about equidistant from the beaks, feebly striated or smooth; shell of moderate size, subelongate or rostrate, longer than high; pallial sinus inconspicuous or obsolete.

Type: *Gnathodon trigonus*, Petit = *G. mendicus*, Gould.

The hook of the anterior lateral tooth is almost obsolete in this species, especially in the young, and it was chiefly upon this character that Conrad separated it, leaving *G. flexuosus* with the typical species; but the sum of all the characters, if taken into account, would modify this view. Carpenter saw the difference ten years earlier, and would have utilized the name *Rangia* for the short-toothed species; but this proceeding would be contrary to the accepted rules of nomenclature, since *Rangia* was based solely upon the same species as *Gnathodon*, and must stand or fall with the priority of application to that special type.

GNATHODON (RANGIANELLA) MENDICUS, Gould.

Plate VII, fig. 2.

Mactra mendica, GOULD., Proc. Bost. Soc. Nat. Hist., IV, p. 88, Nov., 1851; Journ. B. S. N. H., VI, p. 393, Pl. XV, fig. 4, Oct., 1853.

Gnathodon mendicus, CARPENTER, P. Z. S. 1856, p. 200; Mazatlan Sh., p. 549, 1857; Rep. Br. Assoc. 1863, pp. 535, 543, 592.

Gnathodon trigonum, PETIT, Journ. de Conchyl. IV, pp. 84, 166, Pl. VI, figs. 13–15, 1853.—CARPENTER, P. Z. S. 1856, p. 200; Rep. Br. Assoc. 1857, p. 227; Rep. Br. Assoc. 1863, pp. 535, 543, 576, 592, 633.

Gnathodon trigona, CARPENTER, Mazatlan Sh., p. 52, 1857.

Gnathodon truncatum, PETIT, Journ. de Conchyl. IV, p. ii, of expl. pl., 1853.

Gnathodon Lecontei, CONRAD. Proc. Acad. Nat. Sci., VII, p. 31, 1854; not of Conrad, Journ. Acad. 1853.

Rangia trigona, ADAMS, Gen. Rec. Moll. II, p. 380, 1858.

Rangia mendica, PRIME, Proc. B. S. N. H. VII, p. 347, 1861.

Rangianella trigona, CONRAD. Am. Jour. Conch., III, suppl., p. 30, 1868.

Mazatlan, Mexico, Lieut. Green, Rolland de Roquan, Reigen, etc.; living in brackish water.

I have examined authentic specimens of both *G. mendicus* and *G. trigonus* and there seems to be no doubt of their identity.

The epidermis of this species is of a straw color, varying to greenish yellow, darker on the posterior slope, where it often becomes fibrous, and having a paler lozenge-shaped area over the hinge, which, however, is not circumscribed by any groove. Internally the shell is polished outside of the area inclosed by the pallial line. The latter is feebly waved, but hardly indented. The lateral teeth are nearly equal, feebly granulose, the anterior with the "hook" almost obsolete. Although the shell usually has a smooth internal margin it is sometimes radiately striated, especially above the hinge, and the lines of growth are often beaded here and there with short radiating threads much more regular and distinct than those sometimes notable on *G. cuneatus*. A faint wrinkled sculpture is constantly present on the posterior slope and seems characteristic of the species. The umbones are quite smooth. The specimens I have seen average about 25 mm. (1 inch) in length, 18 mm. in height, and 12.5 mm. in diameter.

GNATHODON (RANGIANELLA) FLEXUOSUS, Conrad.

Plate VII, figs. 3, 6.

Gnathodon flexuosus, CONRAD, Am. Journ. Sci., 1st ser., XXXVIII, p. 92, fig. 1839; Proc. Acad. Nat. Sci. Phila., VII, p. 31, 1855.

Gnathodon rostratum, PETIT, Journ. de Conchyl. IV, pp. 84, 164, Pl. V., figs. 1–3, 1853.

Rangia flexuosa, CONRAD, Proc. Acad. Nat. Sci. Phila. for 1860, p. 232; Am. Journ. Conch., III, supplem., p. 30, 1868.

Rangia rostrata, PRIME, Proc. Bost. Soc. N. Hist., VII, p 348, 1861.—ADAMS, Gen. Rec. Moll., II, p. 380, 1858.—CONRAD, Am. Journ. Conch., III, suppl., p. 30, 1868.

Living on the coast of the Gulf of Mexico from northern Florida to Vera Cruz, Mexico, in suitable places. Apparently a denizen of pure salt water.

Length, 43; height, 30; diameter, 26 mm. in the adult.

This is apparently a rare species. I have never seen a perfectly fresh specimen. It can be distinguished from any other Atlantic species by its short, subequal, lateral teeth, rostrate shape, and obsolete pallial sinus. The crenulations of the teeth are very feeble and, in worn specimens, sometimes invisible; but this is a character which varies much in individuals, as can be observed in any good series of *G. cuneatus.* The shell is much heavier than *G. mendicus*, and has the lateral teeth more unequal, the anterior lateral being strongly hooked. The pallial line has no reëntrant angle, but a recess is formed by the base of the adductor scar and the vertical extension of the pallial impression. The epidermis is straw yellow. I have observed no beading along the lines of growth, and no sculpture, on the posterior slope, except incremental lines, on any of the specimens I have examined. The shell varies a good deal in height relative to its length, and the posterior end may be flexed upward or downward or produced horizontally. It is perceptibly rostrate. I have called attention to the fact that *G. cuneatus* has a rostrate variety, of which the outline simulates that of *G. flexuosus*, and must now add a peculiar variety of *G. flexuosus* which tends in the opposite direction.

GNATHODON FLEXUOSUS var. PETITIANUS, Dall.

Plate VII, fig. 5.

In this variety the shell has a height of 30 and a length of 36·5 mm. compared with a height of 29 and a length of 43 mm. for the typical *flexuosus;* the posterior slope is convex and the rostrum short, rounded, and bent downward, the pallial line has a faint sinuation, and the "hook" on the anterior lateral is obsolete. The diameter of the shell would be about 21 mm. The valve is lighter than any specimens of G. *flexuosus* which have come to my notice and considerably more swollen. It is possible that it may represent a distinct species, but this can not be determined without a good series of fresh specimens. A single somewhat worn left valve was obtained by the Mexican geographical commission at Vera Cruz, and is now in the National Museum (No. 57668*a*).

I have referred it to *G. flexuosus* on account of the short lateral teeth and feeble pallial sinus; if additional material should prove it to be distinct, the varietal name now given may be taken as specific. No indication of external sculpture except incremental lines is visible; the epidermis is absent from the specimen.

G. flexuosus possesses more constantly than any other species a character occasionally found in each of them, namely, the presence at the anterior border of the cartilage pit of a thin accessory lamella between the pit and the deltoid cardinal tooth of the left valve. This lamella, when perfect, looks like an additional cardinal tooth, and is always best developed in the left valve, but it is usually more or less absorbed or even absent. It is common to all the *Mactridæ.* The mar-

gin of the valves, especially near the hinge, sometimes shows faint radiating striation, as already noticed in *G. mendicus.*

Spurious or Doubtful Species.

MULINIA GUADELUPENSIS, Recluz.

Mactra guadelupensis, RECLUZ, Journ. de Conchyl., III, p. 249, pl. 10, figs. 4, 4′, 1852; Journ. de Conchyl., IV, p. 414, 1853.—BEAU, Cat. Sh. Guad., p. 26, 1858.—KREBS, W. I. Marine Sh., p. 105, 1864.

Gnathodon guadalupensis, REEVE, Conch. Icon., XIX, No. 2, 1873.

Mactra donaciformis, KREBS, W. I. Mar. Shells, p. 105, 1864; not of Gray or Reeve.

Gnathodon Cantrainei (RECLUZ *ms.*), REEVE., Conch. Icon., XIX, Gnathodon, fig. 3, Oct., 1873.—GUNDLACH, Ann. Soc. Esp. de Hist. Nat., XII, pp. 280, 322, 1883.

Beach at Aguadilla, Porto Rico, dead shells cast up on the shores of the creek, Gundlach; Nevis, Sowerby; Guadelupe, Recluz, Beau; Guaivea on the coast of Venezuela, Blume in Swift Coll.

Gray described a shell in 1837 under the name of *donaciformis*, but his description was inadequate. It was later figured by Sowerby in the zoology of the voyage of the *Blossom*, Capt. Beechey, and on this figure the name must rest, as there is no other means of identifying the shell. It represents a species found on the west coast of middle America from Panama to the Colorado River. It is quite a variable shell but normal specimens agree well with Sowerby's figure. It was stated by Gray to come from the "South Seas" (then a term including most of the Pacific); Sowerby gave the locality as "Nevis," an island in the West Indies where Beechey did not touch; later Reeve figured a shell, probably young, said to be from New Zealand, under Gray's name. The reference to "Nevis" led Krebs and others to identify a rather similar but smaller species named *guadelupensis* by Recluz with the *donaciformis* of Sowerby and Gray. Recluz' species was subsequently figured by Sowerby (1873) in his continuation of Reeve's Iconica as a *Gnathodon*, a not unnatural mistake, since these Mulinias and *Rangianella* can barely be separated generically. At the same time another *Mulinia*, probably a mere variety of *guadelupensis*, is figured by Sowerby under the (ms.?) name of *Cantrainei* Recluz, and also referred to *Gnathodon*. From an examination of authentic specimens there seems to be no question of the identity of *G. Cantrainei* with *G. guadelupensis*, while it is absolutely certain that both belong to the genus *Mulinia* of Gray.

This, however, is not the final disposition of the matter. The small *Mulinia*, named *lateralis* by Say, is well known, chiefly from northern specimens. It extends from Massachusetts Bay to the Antilles. The northern specimens are rather rude, but a series showing the geographical range also shows that, as we follow the species south, it becomes more delicate, lighter, and develops several varieties, one of which was named *Mactra rostrata* by Philippi (not of Spengler) and *Mactra corbuloides*, by Deshayes. This rostrate form is connected with the type by insensible gradations. The species under favorable circum-

stances attains the length of an inch and is quite variable in form, as are all these small Mulinias. It is my opinion that a complete geographical series will show that *M. guadelupensis* is merely a well-grown local race of the *M. lateralis*. Both have a preference for brackish water.

GNATHODON? VALDENSIS, Dunker.

Gnathodon valdensis, DUNKER, Monog. Norddeutsch. Wealdenbild., p. 57, taf. XIII, Figs. 5 a–e, 1846.—SANDBERGER, Land und Süsswasser conchyl. der Vorwelt, p. 54, Pl. II, Figs. 10, 10a, 1870.

Wälderthon des Gravinghagener stollens bei Bielefeld, Germany; Wealden formation of North Germany.

This species has the aspect of a *Cyrena*. The interior and hinge are unknown. It was referred to *Gnathodon* by Dunker because the specimens give no evidence of an external ligament. It is highly improbable that the shell will finally prove to belong to *Gnathodon*, both on account of its age and its locality, but it will certainly be a matter of interest to determine its proper place and it is to be hoped that this will soon be accomplished.

SPISULA? QUADRICENTENNIALIS, Harris.

Gnathodon, new sp., HARRIS, Fourth Ann. Rep. Texas Geol. Survey, Table of species Galveston well, 1893.

Gnathodon quadricentennialis, HARRIS, Fifth Ann. Rep. Texas Geol. Survey. [In press].

From the upper Miocene, 2100 to 2250 feet, in the Galveston artesian well, Galveston, Texas; State Geological Survey.

After a careful examination of specimens of this species kindly furnished by Prof. Harris, I am inclined to refer this to *Spisula*, notwithstanding the inequality of the lateral teeth. The ligament appears to have been partly external, which would remove the species from *Gnathodon*, unless this feature is due to wear, which seems unlikely. The shell is nearly smooth externally, rather elongated, evenly rounded at each end, quite inequilateral, the longer posterior part having long curved laterals, transversely striated. The hinge seems otherwise like that of *Spisula;* the pallial sinus is well marked, the beaks adjacent, low, and inconspicuous, 1.5 mm. from the anterior end. Lon. 8.5, alt. 5.0, diam. 4.0 mm.

MULINIA MINOR, Whitfield?

Rangia? (Perissodon) minor, WHITFIELD, Moll. and Crust. of the Miocene form of N. J., p. 84, pl. 15, figs. 4–6 [in press]; not of Conrad.

Miocene marl of Shiloh, N. J., Burns.

This species doubtfully referred to Conrad's *R. minor* [= *G. clathrodon*, jr.], and well figured by Prof. Whitfield, is a young *Mulinia* allied to *M. lateralis*, but too young to identify. The type is in the collection of the National Museum. Only one specimen was obtained by Mr. Burns.

SPISULA? PARVA, Petit.

Gnathodon parvum, PETIT, Journ. de Conchyl., IV, p. 358, pl. 13, figs. 9–10, 1853.—REEVE, Conch. Icon., XIX, *Gnathodon*, fig. 6, 1873.

Rangia parva, ADAMS, Gen. Rec. Moll., II, p. 380, 1858.—CONRAD, Proc. Acad. Nat. Sci. Phila. for 1860, p. 232; Am. Journ. Conch., III, Suppl., p. 30, 1868.

Mactra rostrata, REEVE, Conch. Icon., VIII, Mon. *Mactra*, Pl. XIX, fig. 104, 1854; not of PHILIPPI, Zeitschr. Mal., 1848, p. 152, nor of SPENGLER, 1802.

Brisbane River, Moreton Bay, Australia, Petit.

Specimens of Petit's shell in the National Museum received from H. Cuming were named by the latter *Mactra rostrata*, Spengler. Spengler cites for a figure of his species the Conchylien Cabinet, vol. 12, tab. 242, fig. 4197, but there is no such plate or figure in the volume referred to, though he may have had proofs of a plate which never was published. His species is quite distinct, but Reeve has figured our shell, as identified by Cuming, under Spengler's name. The shell is a *Spisula*, the ligament being externally visible, though partly inserted in the cartilage pit. The laterals are very sharply striated. In the specimen received from Cuming the lateral teeth proper are in the left valve.

ISOCARDIA? TENUIDENS, Whitfield.

Gnathodon? tenuidens, WHITFIELD, Lam. Raritan Clays, p. 27, pl. 11, figs. 7–10, 1885.

This species is only known as an internal cast from the Cretaceous beds known as the Plastic Clays of New Jersey. It is a thin-shelled salt water bivalve, having much the appearance of an *Isocardia*. It was but doubtfully referred to the genus *Gnathodon* by Whitfield, and I believe it should be referred to the *Isocardiidæ*. It has nothing but the prominent and distant beaks to connect it with *Gnathodon*.

EXPLANATION OF PLATE VII.

Fig. 1. *Gnathodon cuneatus*, GRAY, exterior of adult specimen 60 mm. long. Mus. Reg. No. 60793, p. 93.

Fig. 2. *Gnathodon mendicus*, GOULD, interior of specimen 23.5 mm. long. Mus. Reg. No. 103899, p. 98.

Fig. 3. *Gnathodon flexuosus*, CONRAD, exterior of an adult specimen 43 mm. long. Mus. Reg. No. 6134, p. 98.

Fig. 4. *Gnathodon Lecontei*, CONRAD, one of the typical specimens, the hinge somewhat weatherworn, length 22 mm. Mus. Reg. No. 6833, p. 96.

Fig. 5. *Gnathodon flexuosus* var. *Petitianus*, DALL, from the typical specimen 36.5 mm. long. Mus. Reg. No. 57668*a*, p. 99.

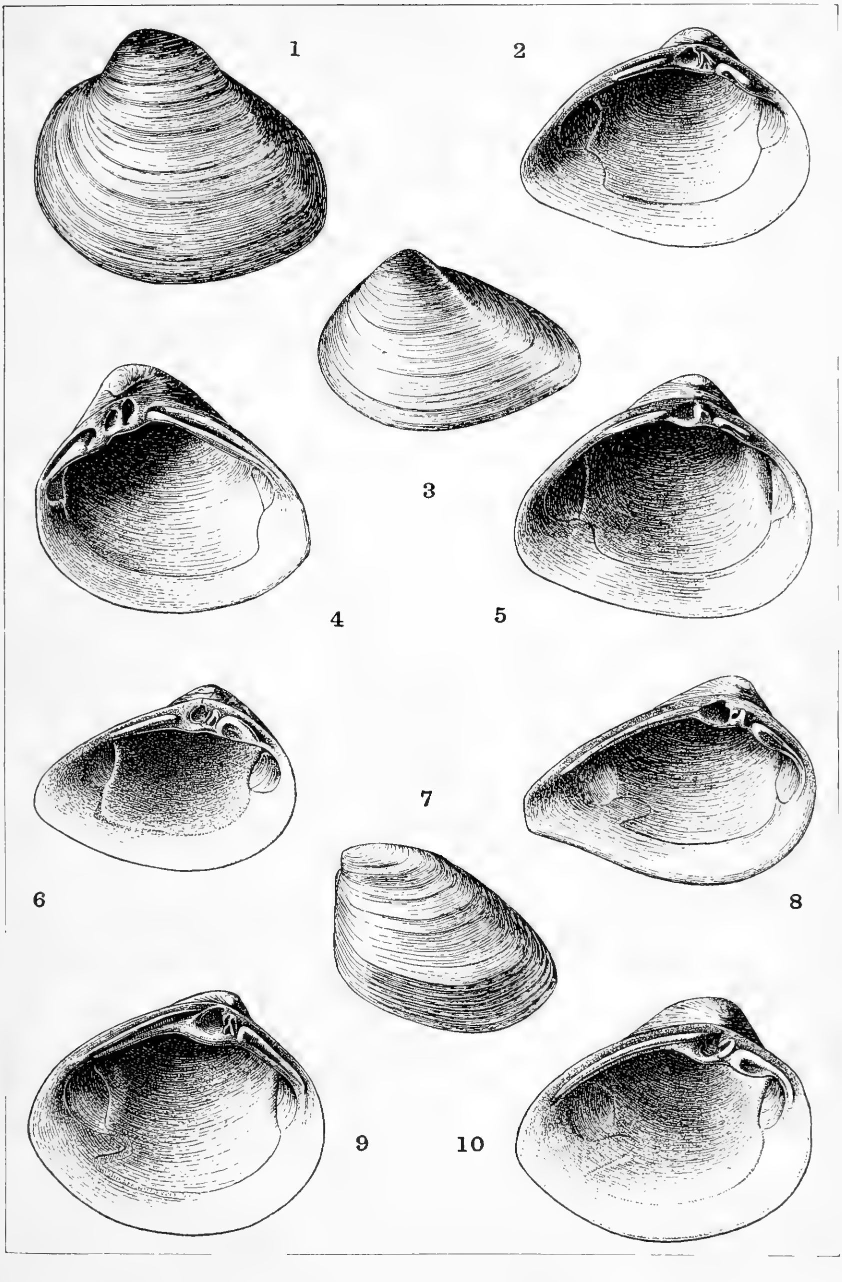
Fig. 6. *Gnathodon flexuosus*, CONRAD, interior, the shell a little worn, the same specimen is figured at fig. 3; p 98.

Fig. 7. *Gnathodon Johnsoni*, DALL, type specimen 17.5 mm. long. Mus. Reg. No. 107033, p. 96.

Fig. 8. *Gnathodon cuneatus* var. *nasutus*, DALL, interior of type specimen 34 mm. long, Mus. Reg. No. 106988, p. 94.

Fig. 9. *Gnathodon clathrodon*, CONRAD (em.), interior of specimen 40 mm. long, from the Croatan beds, Pliocene of North Carolina. Mus. Reg. No. 112296, p. 95.

Fig 10 *Gnathodon cuneatus*, GRAY, interior of valve 60 mm. long. Mus. Reg. No. 60793, p. 93.



GNATHODONS OF NORTH AMERICA.

ON THE NOMENCLATURE AND CHARACTERISTICS OF THE LAMPREYS.

By THEODORE GILL, M. D., PH. D.

IN 1870, Dr. Günther took up the name *Petromyzon branchialis* for what was before generally called *P. planeri*. In 1882, assuming the correctness of that determination and that there were good reasons for the identification, I accepted it and also the name *Ammocætes*, based on the *P. branchialis*, for the genus called *Lampetra* by Gray. It was with much reluctance that I took such a step, and only in deference to the rules of nomenclature regulating such cases, common among the acalephs, especially the hydroids, but rare among vertebrates. The reluctance to adopt the name *Ammocætes* with this new range has, I am sure, been shared by many others, and expression has lately been given to it by Prof. Gage in his valuable memoir on "The Lake and Brook Lampreys of New York" (Wilder book, p. 437). Prof. Gage's own researches appear to furnish a perfectly legitimate way out of the dilemma.

According to Prof. Gage (*op. cit.*, p. 456), "up to the present time there has been no way discovered of distinguishing the larvæ of the lake and of the brook lamprey. As the two species occupy the same spawning ground and sometimes spawn in the same nest great care is necessary in order not to confuse the two. After the larvæ leave the nest they apparently go to the same sand bed." *

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* The after life of the species is, however, quite different.

"The brook lamprey does not apparently increase in length after transformation, for many of the transformed ones at the spawning season are of less size than the just transformed ones."

"The lake lamprey upon transforming is only about one-half to one-fourth the length and probably not one-tenth bulk of the spawning ones." (Gage, *op. cit.*, pp. 452, 453.)

A lamprey half the length of another would equal an eighth of the bulk, and one a fourth the length would only reach one-sixty-fourth the bulk, if the proportions corresponded.

As Prof. Gage had unusual opportunities for investigation, and "since 1875 lost no opportunity of studying the lampreys at all stages of life" (*op. cit.*, p. 423), his conclusions are especially valuable, and may be safely used in a reconsideration of the question of nomenclature.

Why has *Ammocœtes branchialis*, then, been identified specifically with *Petromyzon planeri*, thus necessitating the restoration of the former name?

AMMŒCETES COMMON TO ALL ARCTOGÆAN LAMPREYS.

The memorable researches of Dr. August Müller, resulting in the discovery that an *Ammocœtes* was simply a larva of a lamprey, happened to be conducted where the *Petromyzon planeri* was the species at hand, and, inasmuch as the larvæ in his possession developed into *Petromyzon planeri*, the identification was correct. The mistake (if it can be considered as such) was in assuming that every *Ammocœtes* was a larval *Petromyzon planeri*, and that the *Ammocœtes* or *P. branchialis* of Linné was *specifically* identical with *P. planeri* and with that alone.

It now appears that what would be determinable as an *Ammocœtes branchialis* may be the larva of *any* arctogæan lamprey, inasmuch as the lake lamprey (*Petromyzon marinus* var.) and brook lamprey (*Lampetra* sp.*) are most distinct from each other. Inasmuch also as the sea lamprey (*Petromyzon marinus*) ascends fresh-water streams to breed, there was no reason for identifying *P. branchialis* with one rather than another species, the definition applying to one as well as to another, and doubtless the larvæ of the three European species (*P. marinus*, *P. fluviatilis*, and *P. planeri*) have been frequently, if not habitually, confused. It follows, therefore, that *P. branchialis* (Linné) and *Ammocœtes* are generic rather than specific synonyms and should be so treated. The name *Lampetra* may be, consequently, revived for the fresh-water lampreys of Europe and eastern America and the synonymy digested as follows.

SYNONYMY.

Genus PETROMYZON.

< *Petromyzon*, LINNÆUS, Syst. Nat., ed. 10., v. 1, p. 230, 1758.
< *Petromyzon*, (DUMÉRIL) CUVIER, Règne Animal, t. 2, p. 118, 1817.
< *Ammocœtes*, (DUMÉRIL) CUVIER, Règne Animal [1e éd.], t. 2, p. 119, 1817 (based on larval form).
= *Petromyzon*, GRAY, Proc. Zool. Soc. London, pt. 19, pp. 235, 236; List Specimens Fish Brit. Mus., pt. 1, p. 137, pl. 1, f. 1 (mouth), 1851.
= *Lampetra*, MALM, Forhandl. Skand. Naturf., 8. möde, p. 580, 1860.
< *Petromyzon*, GÜNTHER, Cat. Fishes Brit. Mus., v. 8, p. 500, 1870.

* The specific identity of either the European *Lampetra planeri* or *L. fluviatilis* with an American species is very doubtful and at least requires verification.

Genus LAMPETRA.

?? *Lampreda*, Rafinesque, Analyse de la Nature, p. 94 (without description or typonym), 1815.

?? *Pricus*, Rafinesque, Analyse de la Nature, p. 94 (without description or typonym), 1815.

= *Lampetra*, Gray, Proc. Zool. Soc. London, pt. 19, pp. 235, 237, 1851; List Specimens Fish Brit. Mus., pt. 1, pp. 137, 140, pl. 1, f. 2 (mouth), 1851.

? *Scolecosoma*, Girard, Expl. and Surveys for R. R. Route to Pacific Oc., v. 10. Fishes, p. 384, 1858 (based on larval form).

= *Petromyzon*, Malm, Forhandl. Skand. Naturf., 8. möde, p. 580, 1860.

= *Ammocœtes*, Gill, Proc. U. S. Nat. Mus., v. 5, p. 523, 1883.

Petromyzon sp. *auct. pl.*

Ichthyomyzon sp., Girard.

FAMILIES.

In 1870 Dr. Günther united the genera *Caragola* and *Mordacia* of Gray, the former of which was based on specimens with the lateral corneous lamellæ preserved, while the latter was founded on a specimen in which they were lost and only exhibiting a single papillary prominence for each. For the combination he prefered the second name of Gray (*Mordacia*), based on a mutilated individual. In 1882 I used in preference the first name (*Caragola*), based on a perfect individual. I have since been led to believe that the precedence of one name by such a little margin as *Caragola* has over *Mordacia* has no value, and that aptness of diagnosis, however desirable, is not necessary to secure priority, and I have therefore followed Dr. Günther in accepting the name *Mordacia* instead of *Caragola*. I have also deemed it proper to elevate the subfamily *Caragolinæ* to family rank, and named it *Mordaciidæ*. References follow.

Family Mordaciidæ.

= *Caragolinæ*, Gill, Proc. U. S. Nat. Mus., v. 5, p. 524, 1882.

= *Mordaciidæ*, Gill, Mem. Nat. Acad. Sc., v. 6, p. 129, 1893.

Petromyzontidæ pt., *auct. pl.*

Hyperoartia with two distant lateral tuberculigerous laminæ developed from the upper arch of the annular cartilage.

The only known genus is *Mordacia*.

With this is to be contrasted the family *Petromyzonidæ* as thus restricted, viz:

Family Petromyzonidæ.

< *Petromyzontidæ*, Gill, Proc. U. S. Nat. Mus., v. 5, p. 521, 1882. (Full syn. given.)

= *Petromyzontidæ*, Gill, Mem. Nat. Acad. Sc., v. 6, p. 129, 1893.

Hyperoartia with a single median tuberculigerous suproral lamina developed from the upper arch of the annular cartilage.

It behooves those who may object to these families to consider why

the character used to distinguish them is not of equal value with the union or separation of lower pharyngeal bones and like modifications generally used.

ORTHOGRAPHY.

In common with almost all other zoologists, I have used the name *Petromyzontidæ* for the lampreys. It only lately occurred to me that the form was a suspicious one at least, and, on investigation, I have been obliged to believe that it was due to a false analogy. Certainly the analogous Greek word μύξων has μύξωνος in the genitive, and the corresponding Latin equivalents are *myxon* and *myxonis*. The first to use the form *Petromyzontidæ* appears to have been Prof. Agassiz, in 1850, in Lake Superior (p. 249), and the Edinburg New Philosophical Journal (v. 49, p. 242). It is probable that he was led to this form, without sufficient reflection, by being misled by analogy with words ending in *—odon* (*Tetraodon*, *Diodon*, etc.). Bonaparte had long before given the better form, *Petromyzonidæ*, and this should be revived.

EXOMEGAS.

The genus *Exomegas*, proposed in 1882 (Proc. U. S, Nat. Mus., v. 5, p. 524) for the *Petromyzon macrostomus* of Burmeister, has been justified by the recent publication of a memoir on the species by Dr. C. Berg,* who has, however, referred it to the genus *Geotria*. I have recently called attention in Science for January 19, 1894 (v. 23, p. 30, "A South American lamprey"), to certain discrepancies between the description and figure and the advisability of reexamining the animal.

A detailed comparison of the contrasting skeletal peculiarities of *Petromyzon* and *Lampetra* is very much needed. It may be hoped that Prof. Gage will extend his investigations and give us the requisite information.

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*Anales del Museo de la Plata [etc.]. Seccion zoologica I. Geotria macrostoma (Burm.) Berg y Thalassophryne montevidensis Berg.—Buenos Aires—1893.

THE NOMENCLATURE OF THE MYLIOBATIDÆ OR AËTOBATIDÆ.

By THEODORE GILL, M. D., PH. D.

IN 1888, President Jordan proposed, for very plausible reasons, to revive Blainville's name *Aetobatus* (used in the form *Aetobatis*) for the genus long known as *Myliobatis.** I hastily followed him and have repented at leisure. My reasons for now dissenting are as follows:

AËTOBATUS.

Blainville, in 1816, published a new scheme for the classification of the "Selaca" or Plagiostomes (which he had studied with Mr. Prevost) and divided them into three genera or families: "I. Gen. aut Fam. Raia;" "II. Genus aut Fam. Squatina," and "III. Genus aut Fam. Squalus." The rays were subdivided into 7 groups bearing generic names: *Dasybatus* [=*Raiidæ*], *Trygonobatus* [=*Dasybatidæ* without *Urolophus*], *Aëtobatus* [=*Myliobatidæ*], *Dicerobatus* [=*Mantidæ*], *Leiobatus*† [=*Urolophus*], *Narcobatus* [=*Torpedinidæ*], *Rhinobatus* [=*Rhinobatidæ*], and *Pristobatus* [=*Pristidæ*+*Pristiophoridæ*].

Blainville gave a full and excellent diagnosis of *Aetobatus*, and included "11 nominal species of Myliobatids in the genus. They were as follows:‡ Vulgaris (*M. aquila*?); Obtusus (?); Flagellum (*Ae. flagellum*); Lobatus (*Rhinoptera*?); Sinensis (?); Nichofii (*M. Nieuhofii*); Fili-

* President Jordan was perfectly logical in his conclusions. *Aetobatus* was prior to *Myliobatis* and covered exactly the same group. Remembering this, but not having Blainville's memoir on hand at the time, temporarily forgetting the entire course of reasoning which had previously influenced me (herewith outlined), and fearing that prejudice in favor of accepted usage might have unduly prevailed in my mind, I noted the change, intending to consult Blainville's papers before publication, but the work could not then be found. The only reason why *Aetobatus* had not been revived before was because it was supposed to be subsequent to *Myliobatis*. (*See* Gray's List, p. 128, and synonymy, where *Myliobatis* is erroneously attributed to "*Dum.* Zool. Anal., 1806.")

†*Leiobatus* Bl. was anticipated by *Leiobatus* Raf. (Car., p. 16, 1810) =*Rhinobatus*.

‡The initial capitals are repeated from Blainville's memoir.

caudatus (?); Hamatus (?); Ocellatus (*Ae. narinari?*); Narinari (*Ae. narinari*); Forsteri(?)

The only species of this list *that can be certainly identified* by name is the *narinari*, the type of the Müllerian genus *Aetobatis.* By assuming that *Nichofii* is a misprint for *Nieuhofii*, we are led to another probable identification. The other specific names are new and can only be guessed at; the results of such guesses are given in brackets after the several names, when there are good grounds for guessing. But the genus must be determined by the *known species named* and those belong only to the genus *Aetobatis*, M. & H.

MYLIOBATIS.

Cuvier in 1817, adopted from manuscript of Duméril the name *Myliobatis* for the same group called by Blainville *Aëtobatus.* In this course he was followed by almost all succeeding naturalists.

GENERA OF MYLIOBATIDES.

Müller and Henle in 1838 distributed the species combined under the names *Aëtobatus* or *Myliobatis* into three genera, *Myliobatis*, *Aetobatis*, and *Rhinoptera* (Cuv., 1829). They ascribed to themselves the name *Aetobatis.* This arrangement was generally adopted by later writers.

AGASSIZ'S VIEWS.

Agassiz in 1843 (Poiss. Fos., III, p. 325), took the correct view of nomenclature in the following passage:

> 2°, *Du genre Aetobatis M. et H.*
>
> M. de Blainville désigna sous le nom générique, d'*Aetobatis* l'ensemble des Mourines connues à l'époque où il publiait son ouvrage. Ce genre n'était donc alors qu'un simple synonyme du genre *Myliobates* de M. Duméril.* Plus tard MM. Müller et Henle subdivisèrent ce groupe en plusieurs genres, il conservèrent le nom *Myliobates* au genre dont le *Raja aquila* des auteurs peut être considéré comme le type, et ils restreignirent le nom de *Aetobatis* au genre dont le Narinari de Margraf est l'espèce la plus anciennement connue.

This, it seems to me, is a perfectly legitimate view and use of the two names. Both names, *Aëtobatus* and *Myliobatis*, might have been retained for different sections of the old genus, if no other considerations had forbidden. Both of those names, however, as President Jordan has reminded me, were anticipated by a name given by Rafinesque in 1810.

CEPHALEUTHERUS.

Rafinesque, in his "Indice d'Ittiologia Siciliana," has a genus *Cephaleutherus* interposed between his *Mobula* (=*Cephaloptera* Dum.) and *Uroxis* (Trygon auct.), which, according to Dr. Jordan, is a *Myliobatis.*

* A less equivocal expression would be that *Myliobatis* was a synonym of *Aetobatis* since the former name (1817) was subsequent to the latter (1816).

It is not, however, mentioned by Doderlein in his very full synonyms of the *Myliobatids* of the Mediterranean, and the book in question cannot be found. While I have little doubt that Dr. Jordan is correct in his identification and that the name *Cephaleutherus* should be taken for *Myliobatis*, I defer doing so until I am able to consult the Indice or a copy of it. Meanwhile I retain the name *Myliobatis*, but adopt for the family *Aëtobatidæ*.

SYNONYMY.

The principal synonyms of the family and its primary divisions are as follows:

Family AËTOBATIDÆ.

=*Myliobatides*, MÜLLER & HENLE, Syst. Beschreib. Plagiostomen, p. 176, 1841.
=*Myliobatidæ*, ADAMS, Man. Nat. Hist., p. 87, 1854.
=*Myliobatidæ*, RICHARDSON, Encycl. Brit., 8. ed., v. 12, p. 328, 1856.
=*Myliobatoidei*, BLEEKER, Enum. Sp. Piscium Archipel. Indico, p. xiii, 1859.
=*Myliobatoidæ*, GILL, Cat. Fishes E. Coast N. America, p. 62, 1860.
=*Myliobatides*, A. DUMÉRIL, Hist. Nat. Poiss., v. 1, pp. 469, 631, 1865.
<*Myliobatidæ*, GÜNTHER, Cat. Fishes Brit. Mus., v. 8, pp. 435, 488, 1870.
=*Myliobatæ*, FITZINGER, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 57, 1873.
=*Aetobatidæ*, JORDAN, Man. Vert. An. N. U. S., 5. ed., p. 22, 1888.
=*Rajidæ* gen. or subf. *early authors*.

Subfamily MYLIOBATINÆ.

<*Myliobatini*, BONAPARTE, Nuovi Annali delle Sci. Nat., t. 2, p. 130, 1838; t. 4, p. 182, 1840.
<*Myliobatina*, GRAY, List Fish B. M., part 1, p. 127, 1851.
=*Myliobatinæ*, AGASSIZ, Proc. Boston Soc. Nat. Hist., v. 6, p. 385, 1861.
=*Myliobatinæ*, GILL, Ann. Lyc. Nat. Hist. New York, v. 8, p. 136, 1865.
<*Myliobatina*, GÜNTHER, Cat. Fishes Brit. Mus., v. 8, pp. 435, 488, 1870.
=*Cephaleutherinæ*, JORDAN, Mss.

Genus MYLIOBATIS.

=*Cephaleutherus*, RAFINESQUE, Ind. Ittiol. Sic., p. —, 1810. (Fide Jordan Mss.)
<*Myliobatis*, (DUMÉRIL) CUVIER, Règne Animal, v. 2, p. 137, 1817.
=*Myliobatis*, MÜLLER & HENLE, Mag. Nat. Hist., v. 2, p. 90, 1838.
=*Myliobatis*, MÜLLER & HENLE, System. Beschreib. Plagiostomen, p. 176, 1841.
<*Holorhinus*, GILL, Proc. Acad. Nat. Sci. Phila., v. 14, p. 331, 1862. [*Holorhinus* may hereafter be restored to generic rank, and is at least a good subgenus.]
=*Myliobatis*, GILL, Ann. Lyc. Nat. Hist. New York, v. 8, pp. 136, 137, 1865.
=*Aetobatis*, JORDAN, Man. Vert. An. N. U. S., 5 ed., p. 23, 1888.
Aëtobatus sp., BLAINVILLE.

Subfamily AËTOBATINÆ.

=*Aëtobatinæ*, AGASSIZ, Proc. Boston Soc. Nat. Hist., v. 6, p. 385, 1861.
=*Aetobatinæ*, GILL, Ann. Lyc. Nat. Hist. New York, v. 8, pp. 135, 136, 1865.
Myliobatina gen. *Auct. pl.*

Genus AËTOBATIS.

<*Aëtobatus*, BLAINVILLE, Journal de Physique, t. 83, p. 262, 1816.
=*Aetobatis*, MÜLLER & HENLE, Mag. Nat. Hist., v. 2, p. 90, 1838.
<*Zygobates*, AGASSIZ, Rech. Poiss. Foss., v. 3, p. 328, 1843.
=*Stoasodon*, CANTOR, Cat. Malayan Fish., p. 434, 1850.
<*Goniobatis*, AGASSIZ, Proc. Boston Soc. Nat. Hist., v. 6, p. 385, 1861.
Myliobatis sp., DUMÉRIL, *etc.*

ORIGINAL DIAGNOSIS OF AËTOBATUS.

As the works in which Blainville published his descriptions of *Aëtobatus* are inaccessible to many investigators, the description published in the Journal de Physique (vol. 83, p. 263, 1816) is here reproduced.

3°, *Aëtobatus aut R. Aquilæ.*

Car. Corp. cum P. P. aquilæ formi; Capite crasso non rostrato, appendice simplici anticè instructo; Oculis lateralibus; Dentibus latis, lævibus, polygonis, coalitis, palatinis; P. P. acutis, margine antico convexo, postico concavo; P. V. ut in præcedente [*Trygonobatus*]; P. S. unica ad radicem caud. sæpè longissimæ, flagelliformis, aculeo serrato armatæ, extremitate impennis.

Spec. Vulgaris; Obtusus: Flagellum; Lobatus; Sinensis; Nichofii; Filicaudatus; Hamatus; Ocellatus, Narinari, Forsteri.

THE NOMENCLATURE OF THE FAMILY PŒCILIIDÆ OR CYPRINODONTIDÆ.

By Theodore Gill, M. D., Ph. D.

In my "Families and Subfamilies of Fishes" (1893, No. 133) I have adopted *Pœciliidæ* instead of *Cyprinodontidæ* for the family at present generally known by the latter name.

It is quite true that Prof. Agassiz was the first to recognize the family so called, but he simply gave the plural form of *Cyprinodon*, and not a name with the patronymic suffix now almost universally used to denote families, and he did not define it, but simply gave it to the residuum left after defining the *Cyprini*. Little later Bonaparte gave a regular family name (*Pœcilidæ*) derived from the earliest established name of a genus of the family and that name was several times employed by him and others while the name *Cyprinodontes* remained in abeyance; he also regularly defined it. The first regular use of the latter name with a patronymic suffix (*Cyprinodontidæ*) was by Sir John Richardson in 1856.

Another objection to the name *Cyprinodontidæ* which may reconcile us to its abandonment is that it expresses a taxonomic falsehood and is even now constantly misleading persons. In the part of the great "New English Dictionary," lately published (v. 2, p. 1306), a "*Cyprinodont*" is defined as "a malacopterygious fish of the family *Cyprinodontidæ*, of which the typical genus is *Cyprinodon;* they differ from the Cyprinids in having the jaws more projecting and toothed." In the recent manual of Moreau (1892, p. 479), the "Cyprinodontides" and "Cyprinides" are approximated in an analytical table and simply contrasted on account of the presence of jaw teeth ("mâchoires dentées") in the former and the absence (mâchoires "non dentées") in the latter. It certainly is time for trained ichthyologists to have learned that there is no affinity between the two types, and that they differ so radically in all essential features of organization that they should be referred to different orders. Yet Valenciennes, in the penultimate volume of his great work (Hist. Nat. Poiss., XXI, p. 455), attempted to justify the

retention of the Cyprinodonts in the same *family* with the Cyprinids and their natural allies! The Cyprinodonts or Pœciliids are really related to the Esocids and Umbrids, and to them they should be approximated in the suborder *Haplomi.*

The chief synonymy of the family and the type containing subfamily is given in the following summary, from which the usage of various naturalists may be learned:

Family PŒCILIIDÆ.

= *Cyprinodontes,* AGASSIZ, Mem. Soc. d'Hist. Nat. de Neuchatel, t. 1, p. 35, 1834; Poiss. Foss., v. 5, pt. 1, p. 12, pt. 2, p. 47.
= *Pœcilidæ,* BONAPARTE, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 194, 1840.
= *Pœcilidæ,* BONAPARTE, Trans. Linn. Soc., v. 18, p. 299, 1840–'41.
= *Pœcilidæ,* BONAPARTE, Cat. Met. Pesci Europei, p. 5, 1846.
= *Cyprinodontes,* MÜLLER, Archiv Naturgesch., 9. Jahrg., B. 1, p. 320, 1843.
> *Anablepidæ,* ADAMS, Man. Nat. Hist., p. 107, 1854.
> *Pœciliidæ,* ADAMS, Man. Nat. Hist., p. 107, 1854.
< *Cyprinodontidæ,* RICHARDSON, Encyl. Brit., v. 12, p. 252, 1856. (Includes also *Diplopterus* (= *Luciocephalus*) and *Vandellia.*)
= *Cyprinodontidæ,* GIRARD, Expl. and Surv. for R. R. Route to Pacific Oc., v. 10, Fishes, p. 302, 1858.
< *Cyprinodontoidei,* BLEEKER, Enum. Sp. Piscium Archipel. Indico, p. xxix, 1859.
= *Cyprinodontidæ,* GÜNTHER, Cat. Fishes, Brit. Mus., v. 6, p. 299, 1866.
= *Cyprinodontidæ,* COPE, Proc. Am. Assoc. Adv. Sci., v. 20, p. 333, 1872.
= *Cyprinodontes,* FITZINGER, Sitzb. K. Akad. der Wissensch., (Wien), B. 67. 1. Abth., p. 38, 1873.
= *Pœciliidæ,* GILL, Mem. Nat. Acad. Sc., v. 6, No. 133, 1893.
Cyprinoides gen., CUVIER, DUMÉRIL (1856), et al.

Subfamily PŒCILIINÆ.

< *Pœcilini,* BONAPARTE, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 195, 1840.
< *Pœcilini,* BONAPARTE, Trans. Linn. Soc., v. 18, p. 299, 1840–'41.
< *Pœcilinæ,* SWAINSON, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 190, 311, 1839.
< *Pœciliini,* BONAPARTE, Cat. Met. Pesci Eur., p. 5, 1846.
= *Cyprinodontidæ limnophogæ,* GÜNTHER, Cat. Fishes B. M., v. 6, pp. 300, 339, 1866.
= *Pœciliinæ,* JORDAN & GILBERT, Syn. Fishes N. Am., p. 327, 1882.

THE DIFFERENTIAL CHARACTERS OF THE SALMONIDÆ AND THYMALLIDÆ.

By Theodore Gill, M. D., Ph. D.

In 1885 the name *Thymallidæ* was published, but without definition. I have on several occasions been requested to give the distinctive characters of the family, and have done so orally. A detailed exposition has been postponed in the hope that I might be able to study the anatomy of the related forms. As no immediate prospect of doing so is offered, however, I submit diagnoses of the *Salmonidæ* as now restricted and the *Thymallidæ*.

In 1871 Prof. Cope, in his system of teleostomous fishes, named as families of his order of *Isospondyli*, among others, the families *Salmonidæ* and *Coregonidæ*. The *Isospondyli* with a diphycercal tail and "basis cranii double" are divided among those with "(*a*) parietals united," and "(*aa*) parietals separated by supraoccipital." The former (*a*) include the *Hyodontidæ*, *Albulidæ*, *Elopidæ*, *Aulopidæ*, Coregonidæ, *Lutodiridæ*, *Sauridæ*, and *Gonorhynchidæ;* the latter (*aa*) compose the *Alepocephalidæ*, Salmonidæ, *Chirocentridæ*, and *Clupeidæ*.

I at first adopted the *Salmonidæ* and *Coregonidæ* in my Arrangement of families, but, on examination of a skull of *Coregonus* shortly before receiving proofs of that article, found that it did not have the "parietals united," but "separated by supraoccipital," and thus agreed with the salmonids. I consequently replaced the name *Coregonidæ* by *Microstomidæ*, but the printers retained the reference to *Coregonidæ* of Cope.

As thus intimated, the true *Coregoni* have the same relations of the supraoccipital, parietals and frontals to each other as the typical salmonids, but there is a genus which manifests the character erroneously attributed to *Coregonidæ* by Cope, and that genus is *Thymallus*.

Thymallus is not only distinguished from the true Salmonine and Coregonine fishes by the junction of the parietals at the middle; it has, in addition, supracostal spines entirely wanting in the others; furthermore, the dorsal is distinguished by its greater development, both in extension and the number of rays, as well as its structure; instead of only one or two simple anterior rays, as in the Salmonines and Corego-

nines, there are in *Thymallus* many (7–11) unbranched rays and the rays in the posterior half are mostly simply bifid. The view generally prevalent (that *Thymallus* is intermediate between the Salmonines and Coregonines, or that it is a member of the latter group), is thus negatived by both the osteological peculiarities and external characteristics. The family *Thymallidæ* is well distinguished.

The diagnostic characters which separate the two families, *Salmonidæ* and *Thymallidæ*, and the two subfamilies of the former are now presented. The genera and their principal synonyms are also added. The desirability of exhibits of exact references to the first introduction and uses of the various synonyms will be evident to those who are conversant with recent works in which the genera have been treated, and will show why the various names here used are employed.

Family SALMONIDÆ.

<*Dermoptères*, DUMÉRIL, Zool. Analytique, p. 146, 1806.
<*Salmonidi*, RAFINESQUE, Indice d'Ittiolog. Siciliana, p. 32, 1810.
<*Dermopteria*, RAFINESQUE, Analyse de la Nature, p. 87, 1815.
<*Salmonoides*, RISSO, Hist. Nat. de l'Europe Mérid., t. 3.
<*Salmones*, CUVIER, Règne Animal [1e éd.], t. 2, p. 159, 1817; 2e éd., t. 2, p. 301, 1829.
<*Salmonides*, LATREILLE, Fam. Nat. Règne Animal, p. 119, 1825.
<*Salmones*, AGASSIZ, Sel. Gen. et Sp. Piscium q. coll. Spix., p. 56, 1829.
<*Salmonacei*, NILSSON, Prod. Ich. Scand., p. 1, 1832.
<*Salmonidæ*, BONAPARTE, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animal. Vertebr. a Sangue Freddo, p. 37,) 1832.
<*Salmonidæ*, SWAINSON, Nat. Hist. and Class. Nishes, etc., v. 2, pp. 184, 283, 1839.
<*Salmonidæ*, BONAPARTE, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4. p. 272, 1840.
<*Salmones*, MÜLLER, Archiv Naturgesch., 9. Jg., 1. B., p. 323, 1843.
<*Salmonöides*, VALENCIENNES, Hist. Nat. des Poissons, t. 21, p. 153, 1848.
<*Salmonidæ*, ADAMS, Man. Nat. Hist., p. 109, 1854.
<*Salmonidæ*, RICHARDSON, Encycl. Brit., 8th ed., v. 12, p. 245, 1856.
<*Salmonoidei*, BLEEKER, Enum. Sp. Piscium Archipel. Indico, p. xxxi, 1859.
<*Salmonidæ*, GÜNTHER, Cat. Fishes Brit. Mus., v. 6, p. 1, 1866.
<*Salmonidæ*, COPE, Proc. Am. Assoc. Adv. Science, 1871, p. 333, 1872.
<*Salmonidæ*, GILL, Arrang. Fam. Fishes, p. 16, 1872.
<*Salmones*, FITZINGER, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 37, 1873.
=*Salmonidæ*, GILL, Rep. Smiths. Inst. 1884, p. 619, 1885.

Diagnosis.—Salmonoideans with a short dorsal fin of normal structure, epipleural appendages not developed, and parietal bones separated at middle by the intervention of the supraoccipital which connects with the frontals, and ripe ova first discharged within abdominal cavity.

Subfamily SALMONINÆ.

<*Truites* (*Trutiformes*), LATREILLE, Fam. Nat. du Règne Animal, p. 119 (tribe). 1825.

<*Salmonini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod, Animal. Vertebr. a Sangue Freddo, p. 37,) 1832.
<*Salmoninæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 5, 283, 1839.
<*Salmonini*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 273, 1840.
<*Salmonini*, Bonaparte, Conspectus Syst. Piscium, 1850.
<*Salmoniformes*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxxi, 1859.
<*Salmonina*, Günther, Cat. Fishes Brit. Mus., v. 6, p. 2, 1866.
<*Salmoninæ*, Gill, Canadian Naturalist, n. s., v. 3, p. 258, 1865.
<*Salmoninæ*, Jordan and Gilbert, Syn. Fishes N. Am., p. 289, 1882.
=*Salmoninæ*, Gill, Mem. Nat. Acad. Sc., v. 6, p. 131, 1893.

Salmonids with a deeply cleft mouth, long lower jaw articulating with the quadrates behind the eyes, and rather narrow supramaxillaries with incurved adoral margins.

The subfamily thus limited includes the genera *Salvelinus*, *Cristivomer*, *Hucho*, *Salmo*, *Oncorhynchus*, and *Brachymystax*.

Genus SALVELINUS.

=*Salvelini*, Nilsson, Prodr. Ich. Scand., p. 7, 1832. (Group of *Salmo*.)
=*Salvelinus*, Richardson, Fauna Bor.-Am., v. 3, p. 169, 1836. (Subg. of *Salmo*.)
=*Baione*, Dekay, Nat. Hist. N. Y., part 4, p. 244, 1842.
=*Rödingar* (*Salvelini*), Nilsson, Öfvers. K. Vet. Akad. Förhandl., 1848, p. 64, 1849.
×*Salmo*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 165, 1848.
×*Fario*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 277, 1848.
×*Salar*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 314, 1848.
=*Salmo*, Rapp, Jahreshefte Ver. vaterl. Naturk. Württemberg, 10. Jahrg., p. 162; Fische des Bodensee, p. 32, 1854.
=*Salmo*, Siebold, Süsswasserfische von Mitteleuropa, p. 280, 1863.
=*Salvelinus*, Gill and Jordan, Jordan's Man. Verteb. N. U. S., 2. ed., p. 356, 1878.
Salmo, sp. *auct.*

Genus CRISTIVOMER.

=*Cristivomer*, Gill and Jordan in *Jordan*, Man. Vertebr. N. U. S., 2 ed., pp. 356, 359, 1878.
Salmo, sp., *auct. pl.*

Genus HUCHO.

<*Hucho*, Günther, Cat. Fishes B. M., v. 6, p. 140, 1866. (Provisional name for subdivision of Salmo).
<*Hucho*, Jordan, Man. Vertebr. N. U. S., 1. ed., p. 260, 1876.
=*Epitomynis*, Schulze, Fauna Pisc. Germ., p. 38, 1890. (Subg. of Salmo.)
Salmo sp. *auct. pl.*

Genus SALMO.

<*Salmo* [§]* *Truttæ*, Linné, Syst. Nat., ed. 10, v. 1, p. 308, 1758.
<*Salmo*, Lacépède, Hist. Nat. Poiss., v. 5, p. 152, 1803.
<*Salmo*, Cuvier, Règne Animal, v. 2, p. 160, 1817.
<*Salmo* (§ *Truttæ*), Nilsson, Prod. Ich. Scand., p. 70, 1832.
<*Salmo*, Richardson, Fauna Bor.-Am., v. 3, p. 169, 1836. (Subg. of Salmo.)
<*Salmo*, Nilsson, Ofvers. K. Vet. Akad. Forhandl., 1848, p. 64, 1849.
×*Salmo*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 165, 1848.
×*Fario*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 277.
×*Salar*, Valenciennes, Hist. Nat. Poiss., v. 21, pp. 163, 314.

=*Fario*, RAPP, Jahreshefte Ver. vaterl. Naturk. Württemberg, 10. Jahrg., p. 162. (Fische des Boden see, p. 27,) 1854.
=*Trutta*, SIEBOLD, Süsswasserfische Mitteleuropa, p. 280, 1863.
<*Salmo*, GÜNTHER, Cat. Fishes B. M., v. 6, p. 2, 1866.
=*Salmo*, JORDAN, Man. Vertebr. N. U. S., 2. ed., pp. 356, 359, 1878.

Genus ONCORHYNCHUS.

<*Oncorhynchus*, SUCKLEY, Annals Lyc. Nat. Hist. N. Y., v. 7, p. 312, 1862.
=*Oncorhynchus*, GÜNTHER, Cat. Fishes B. M., v. 6, p. 155, 1866.
Salmo sp. *Pallas*, Richardson *et al.*

Genus BRACHYMYSTAX.

=*Brachymystax*, GÜNTHER, Cat. Fishes B. M., v. 6, p. 172, 1866.
Salmo sp., *auct. pl.*

This genus appears to be represented in Europe by the *Salmo obtusirostris* of Heckel or *Thymallus microlepis* of Steindachner (Sitz. K. Akad. Wissensch., 1. Abth., v. 70, p. 367, 1874),* which must therefore be called *Brachymystax obtusirostris.* That species, at least, does not appear to belong to the genus *Salmo* or *Thymallus* as generally defined, and no generic differences between it and *Brachymystax* are evident from the excellent figure and description.

Subfamily COREGONINÆ.

(*Synonyms as subfamily.*)

=*Coregonini*, BONAPARTE, Conspectus Syst. Piscium, 1850.
=*Coregoninæ*, GILL, Johnson's New Universal Cyclopedia, v. 4, p. 1651, 1878.
=*Coregoninæ*, JORDAN & GILBERT, Syn. Fishes N. Am., p. 289, 1882.

(*Synonym as family.*)

?? *Coregonidæ*, COPE, Proc. Am. Assoc. Adv. Sci., v. 20, p. 333, 1872. (Name; not diagnosis.)

Salmonids with a small mouth, short lower jaw articulating with the quadrates under the eyes, and broad supramaxillaries with convex adoral margins.

The subfamily, besides the type genus, *Coregonus*, is generally made to include *Stenodus* or *Luciotrutta*, but I have not been able to examine a skeleton of the latter. It probably represents another subfamily.

Genus COREGONUS.

<*Salmo* [§] *** *Coregoni*, LINNAEUS, Syst. Nat., ed. 10, v. 1, p. 310, 1758.
>*Tripteronotus*, LACÉPÈDE, Hist. Nat. Poiss., v. 5, p. 47, 1803.
<*Coregonus*, LAÉCPÈDE, Hist. Nat. Poiss., v. 5, p. 239, 1803.
<*Les Ombres, Coregonus*, CUVIER, Règne Animal, v. 2, p. 162, 1817.
=*Les Lavarets* (*Coregonus*), CUVIER, Règne Animal, 2. ed., v. 2, p. 306, 1829.
=*Coregonus*, VALENCIENNES, Hist. Nat. des Poissons, t. 20, p. 454, 1848.

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* The identity of *Salmo* (or *Salar*) *obtusirostris* of Heckel and *Thymallus microlepis* was recognized by Dr. Steindachner in 1882 (Sitz. K. Akad. Wiss., 1. Abth., v. 84; Ich. Beitr. xii, p. 15). Nevertheless, in 1886, Dr. Seeley in "The Fresh-water Fishes of Europe," retained the two nominal species, *Salmo obtusirostris* (p. 286) and *Thymallus microlepis* (p. 358). If the genus *Brachymystax* is accepted the species in question should apparently be referred to it.

>*Coregonus*, AGASSIZ, Lake Superior, p. 336, 1850.
>*Argyrosomus*, AGASSIZ, Lake Superior, p. 336, 1848.
=*Coregonus*, GÜNTHER, Cat. Fishes in Brit. Mus., v. 6, p. 172, 1866.
>*Prosopium*, (MILNER) JORDAN, Man. Vertebr. N. U. S. 2. ed., p. 381, 1878,
>*Allosomus*, JORDAN, Man. Vertebr. N. U. S. 2. ed., p. 361, 1878, (subg. of *Argyrosomus*).
Salmo sp., *auct. vet.*

Subfamily STENODONTINÆ.

Salmonids, with a deeply-cleft mouth, long lower jaw, articulating with the quadrates behind the eyes, broad supra-maxillaries with convex adoral margins, and bands of teeth on the broad head of vomer and on the palatines.

Genus STENODUS.

=*Stenodus*, RICHARDSON, Narrative, Artic Land Exp., p. 521, 1836.
=*Stenodus*, RICHARDSON, Encycl. Brit., 8. ed., v. 12, p. 245, 1856.
=*Luciotrutta*, GÜNTHER, Cat. Fishes B. M., v. 6, p. 164, 1866.
Salmo sp., RICHARDSON olim.

The genus *Stenodus* was originally proposed by Dr. (afterwards Sir John) Richardson in an appendix to Back's "Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River," etc., published in 1836. In his remarks on the "Fish," allusion is made (p. 521) to "the *Salmo Mackenzii*, which ascends from the Arctic Sea, and does not exist in the more southern waters. This fish [he continued], though agreeing with the trouts in the structure of the jaws, differs from all the subgenera established by Cuvier in the *Règne Animal* in having the teeth disposed in velvet-like bands, and broader on the vomer and palatine bones. From the crowded minute teeth, the name of *Stenodus* may be given to the subgenus, of which the inconnu, or *Salmo Mackenzii*, is the only ascertained species." In 1856 an elaborate description of the genus was published by the same author. The name *Luciotrutta* was proposed for the same type thirty years after *Stenodus* by Dr. Günther, who was apparently unacquainted with Richardson's propositions.

Family THYMALLIDÆ.

=*Coregonidæ*, COPE, Proc. Am. Assoc. Adv. Science, 1871, p. 333, 1872. (Diagnosis only.)
=*Thymallidæ*, GILL, Rep. Smithson. Inst., 1884, p. 619, 1885.
=*Thymallidæ*, COPE, Syl. Lect. Geol. Pal., p. 23, 1891.
Salmonidæ gen., *Auct. pl.*

Diagnosis.—Salmonoideans with a rather long dorsal fin whose anterior half is composed of graduated simple rays and posterior half of bifurcate or little branched rays, epipleural spines to anterior ribs, the parietal bones meeting at middle and excluding frontals from supraoccipital, and ripe ova first discharged within abdominal cavity.

Genus THYMALLUS.

< *Les Ombres* (*Coregonus*), CUVIER, Règne Animal, v. 2, p. 162, 1817.
= *Les Ombres* (*Thymallus*), CUVIER, Règne Animal, 2. ed., v. 2, p. 306, 1829.
= *Thymallus*, NILSSON, Prodr. Ich. Scand., p. 12, 1832.
= *Aesche, Choregon*, MINDING, Lehrb. Naturgesch. Fische. p. 119, 1832.

The history of *Thymallus* is somewhat complicated with that of *Coregonus*.

In 1816, Cuvier gave the name "Les Ombres (Coregonus. Art.)" to a group composed of the graylings and whitefishes.

In 1829, Cuvier divided the "Ombres" into two genera (or subgenera), naming the "Ombres" or graylings, *Thymallus*, and the whitefishes *Coregonus*.

In 1832, Minding gave the name "Aesche, *Choregon*," * to a genus of which the only species mentioned was the "Thymus-Aesche, *C. Thymallus*." The name was evidently given as a substitute for *Coregonus* of Artedi and Cuvier (1817).

Inasmuch as Cuvier, Fleming, and others simply adopted *Coregonus* from Artedi and Linnæus, I do not think that the fact that they brought into such prominence the *Thymallus* is sufficient to insure the acceptance of that species as the type of *Coregonus*.

Thymallus was preceded by *Thymalus*, a Coleopterous genus named by Latreille in 1802. Those who think that the two conflict may take the name *Choregon* in place of *Thymallus*. †

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* (v. *Χοςηγέω*, ich führe den Chor an.)

† The name *Choregon* is distinct etymologically and in form from *Coregonus*. Artedi, the author of the name, in his Philosophia Ichthyologica (p. 72), gave the following etymology:

"COREGONUS *a κόρη pupilla oculi & γωνια argulus* quia pupilla anteriore parte in angulum acutum procurrit."

ON THE RELATIONS AND NOMENCLATURE OF STIZOSTEDION OR LUCIOPERCA.

By Theodore Gill, M.D., Ph.D.

In a valuable article on *Lucioperca marina*, C. & V.,* Mr. Boulenger has raised two questions of interest, viz:

1. The point to which I now wish to draw special attention is the close affinity which the Black Sea and Caspian species bears to the North American, and especially to *L. canadensis*.

2. *Lucioperca* should date from the first edition of the 'Règne Animal', 1817, where Cuvier (p. 295) does use the Latin name ("ce qui leur a fait donner le nom de *lucioperca*"), although indirectly and without a capital.

The former involves an important question of zoogeography. Is the form in question really related more nearly to the American than to the other European species?

The second involves a question of nomenclature affecting important economical species. Is the passage of Cuvier cited the expression of a historical fact or a nomenclatural proposition?

The great and deserved reputation of Mr. Boulenger calls for an extended consideration of the questions involved, and this I have ventured to attempt.

CLASSIFICATION.

In 1877 I was led to investigate, in company with Dr. Jordan, the interrelationships of the species of *Stizostedion*, and both of us were struck by the contrast between the European and American species, and jointly elaborated the characteristics which we observed, in an analytical synopsis published in the second number of Dr. Jordan's "Contributions to American Ichthyology."†

I have lately reviewed the specimens of the four species in the National Museum in connection with the description and figure of *Lucioperca marina* given by Mr. Boulenger, and the conclusions to which I have

* Proc. Zool. Soc. London, 1892, pp. 411–413, pl. 25.

† Bull. U. S. Nat. Mus. 10.

come are embodied in the following analytical synopsis, slightly modified and extended from our early one.

*. Dorsal fins well separated, the interspace between them more than the diameter of eye; anal fin II, 11–14, longer than high; second dorsal I, 17, to I, 21; spines of the second dorsal and anal closely attached to the soft rays; last dorsal spine scarcely erectile, more or less firmly bound down by the membrane; ventrals separated by an interspace equal to width of their base; canine teeth strong (American species):

†. Soft dorsal comparatively short (its base one-fourth shorter than that of spinous dorsal) and with about 17 soft rays; cheeks, opercles, and top of head more or less closely scaled; body scarcely compressed; size small; pyloric cœca forming two groups, the primary one of four, unequal, moderate, much shorter than the stomach; the secondary of few (1–3) rudimentary ones.......CANADENSE.

††. Soft dorsal rather long (one-sixth shorter than spinous dorsal, with about 20 soft rays; cheeks and upper surface of head sparsely scaled; body more compressed; size large; pyloric cœca three, subequal, all long (about as long as stomach)...VITREUM.

**. Dorsal fins approximated, almost connected by membrane, the interspace being much less than the diameter of the eye; spines of second dorsal and anal loosely connected with succeeding rays; last dorsal spine erectile; ventrals separated by an interspace about two-thirds the width of their base; second dorsal I (II, 16) 22 or 23; anal fin at least as high as long; body compressed; (European species with the body more or less distinctly transversely barred):

‡. Soft dorsal considerably (one-fifth) *shorter* than spinous dorsal; anal fin II, 11–12, as long as high; canine teeth strong; "pyloric cœca 4 to 6".....LUCIOPERCA.

‡‡. Soft dorsal somewhat *longer* than spinous dorsal; anal fin short and high; its length two thirds its height; its rays II, 9–10; canine teeth weak, not much differentiated; body strongly compressed as in the genus *Perca;* "pyloric cœca three" (*Günther*) ....WOLGENSE.

‡‡‡. Second dorsal shorter than spinous dorsal (First D. XII–XIII; Second D. I–II 16–17); anal fin II, 11–12, about as short as high; canine teeth developed; body compressed and banded like a perch; pyloric cœca 5; the longest as long as stomach, the shortest only half as long (*Boulenger*)..............MARINUM.

The relations of *Stizostedion* to other genera appear to me to have been much misunderstood. Dr. Günther and Prof. Seeley have arranged the fresh-water European genera of perciform acanthopterygians in the following manner:

GÜNTHER, 1859 (1886*).	SEELEY, 1886.
1. Perca.	1. Perca.
4. Labrax.	2. Labrax.
9. Acerina.	3. Percarina.
10. Percarina.	4. Acerina.
11. Lucioperca.	5. Lucioperca.
14. Aspro.	6. Aspro.

Most of these genera are undoubtedly related, and belong to the family *Percidæ*, but *Labrax* (including *Dicentrarchus*, *Roccus*, and

*The same essential sequence was adopted in the Handbuch der Ichthyologie, but without numbers.

Morone) is probably a member of a different family. The European Percids seem naturally to fall into the following groups:

Percarina.
Perca.
Stizostedion.
Acerina.
Gymnocephalus.
Cingla.
Aspro.

The relationship of *Perca* and *Stizostedion* is especially close.

The order of the differentiation of the genera from a primitive type may be expressed by the following genealogical tree.

Aspro appears to be the nearest European relation to the American Etheostomines; at least it resembles them most in appearance and the form of the ventrals.

It will be noticed that the character first appreciated by Mr. Boulenger (the relative width of the interspace between the ventral fins as compared with the width of the bases of these fins) is coordinate with the characters previously recognized by Dr. Jordan and myself and therefore corroborates the approximation of the European species and their segregation from the American forms. The evidence therefore appears to be strong in favor of the differentiation of the genus into two primary sections, one including the European fishes and the other the American. The *Lucioperca marina* or *Stizostedion marinum* conse-

* *Gymnocephalus* (Bloch) Blkr. Arch. Néerland Sc., vi. 11, p. 266,=*Leptoperca* (Gill Proc.Acad. Nat. Sc. Phila., 1861, p. 502) is distinguished from *Acerina* by the slender body, prolonged snout, and longer, many-spined (17—19) dorsalis. Its species are *G. schrætzer* (ex Linn) and *G. tanaicensis* (ex Güldenstedt).

quently is associated with the representatives of the genus belonging to its own fauna rather than to those of the American fauna.

THE PROPER NAME OF THE PIKE-PERCHES.

The scientific name generally given to the pike-perches by the American naturalists is *Stizostedion*, or some orthographic modification thereof. Under any form, it is so objectionable to me that I would like to see it displaced, especially by so euphonious and appropriate a name as *Lucioperca*. I therefore long ago sought to find a date for the latter which would anticipate *Stizostedion*, and called attention to the publication of the French name (Les Sandres) in 1817.* I was, however, unable to find any but the French name and between that and the formal bestowal of the latin *Lucioperca* two or three others intervened, *Stizostedion*, *Sandat*, and perhaps *Sandrus*. Although I had come to such a conclusion I was nevertheless disposed to welcome Mr. Boulenger's recent interpretation of Cuvier's words in proposing a subgeneric isolation of the pike-perches, in the hope that *Lucioperca* might be legitimately revived. But another review of the case compels me to adhere (most reluctantly) to my former conviction. That the strain of the interpretation proposed by Mr. Boulenger is too great is rendered evident by the consideration of Cuvier's language, and the action of two of his compatriots and others with regard to it.

In 1817, Cuvier distinguished from the "*Centropomes*" (including *Centropomus* and *Lates*) a new division in the following terms:

Je distingue des CENTROPOMES.

LES SANDRES. CUV.

Qui ont aussi des dentelures au préopercule, sans piquans à l'opercule, mais dont le tête entière est dépourve d'écailles, et la gueule armée de dents pointues et ecartées, ce qui leur a fait donner le nom de *lucio perca*. (*Brochet perche.*)

I had always interpreted this statement to mean that the pointed distant teeth had procured (from others) for the species the name of pike-perch and that the name *Lucioperca* was not formally given to the genus, and in fact that the genus was not really scientifically named. Thus had most others also interpreted the paragraph. An analogous paragraph in the work of Cuvier and Valenciennes (vol. 2, p. 110) seems likewise to support such an interpretation.

Both passages taken together clearly show that Cuvier simply stated a historical fact and did not formulate a nomenclatural proposition.

In 1820, Rafinesque described a pike perch as *Perca salmonea* and proposed a subgenus for it in the following terms:

The *Perca Salmonea* may also form a peculiar subgenus, or section distinguished by the cylindrical shape of the body, long head and jaws, large teeth, and a second spine outside of the opercule over the base of the pectoral fins. It may be called *Stizostedion*, which means pungent throat.

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*See Proc. Acad. Nat. Sc. Phila., 1861, p. 47.

No good objection can be offered against this differentiation as it is pertinent and diagnostic, save as to the second spine, which is simply the extension of the proscapula and is no more evident in the pike-perches than in the typical perches. Rafinesque's diagnosis is, in fact, better than Cuvier's.

In 1819, Bosc* defined the names *Sandat* and *Sandre* in the following words, neither name being used as a scientific or Latin designation of an accepted genus.

Sandat. Synonyme de *Sandre*. (B.)

Sandre. Poisson de nos rivières que Linnæus avoit placé parmi les PERCHES (*perca lucioperca*), et que Lacépède a porté dans son genre *Centropome*. Cuvier vient de le faire servir à l'etablissement d'un sous-genre. Ses caractères sont: tête dépourvue d'écailles; gueule armée de dents pointues et écartées; des dentelures au préopercule; des piquans à l'opercule.

La *Sciène coro* et de l'Ile-de-France paroît devoir faire part de ce sous-genre. (B).

In 1827, Cloquet† defined the genus under the head of "Sandre;" gave, as a pseudoscientific equivalent, the name "Sandat," and defined it as follows:

Sandre, Sandat. (*Ichthyol.*) M. Cuvier a distingué sous ce nom un genre de poissons qu'il a séparé de celui des *Centropomes* de Lacépède, et de celui des PERCHES de Linnæus.

This was defined in the following terms:

Corps oblong, épais, comprimé, écailleux; opercules dentelées sans piquans; tête alépidote; deux nageoires, dents pointues et écartées.

Two species were recognized:

(1) "Le Sandat, *Sandat lucioperca*, N. [i. e. Cloquet]; *Perca lucioperca* Linnæus," =Stizostedion *lucioperca*.

(2) Le "Sandre coro, *Sandat coro*"=*Conodon nobile*.

In 1828 and 1829, Bory de Saint Vincent, in the Dictionnaire Classique d'Histoire Naturelle, adopted as a subgeneric name *Sandat*. Under the head *Perche* (vol. 13, p. 204) he defined the subgenus:

† † † † † Sandre, *Sandat*. Les Poissons de ce sous-genre, formés aux dépens des Centropomes de Lacépède, ont des dentelures au préopercule, mais point de piquans à l'opercule; leur tête est entièrement dépourvne d'écailles, et la gueule est armée de dents pointues et écartées.

Under the heads of Sandat and Sandre, simple cross-references were given, viz:

SANDAT. Pois. *V.* SANDRE et PERCHE, sous-genre CENTROPOME (vol. 15 p. 97.)

SANDRE. *Sandat.* POIS. Sous-genre de Perche. *V.* ce mot. (B.) (vol. 15, p. 98.)

In 1828, Stark‡ defined the genus as follows:

* Nouveau Dictionnaire d'Histoire Naturelle, n. ed., vol, 30, pp. 126, 129.

† Dictionaire des Sciences Naturelles, v. 47, p. 173,

‡ Elements of Natural History, vol. 1, p. 465.

Gen 75.* *Sandrus*. Cuv.

Head entirely destitute of scales; jaws armed with pointed and distant teeth; preoperculi dentated, but operculi without spines.

S. lucioperca and *S. coro* were the admitted species.

In 1828 Cuvier and Valenciennes† for the first time formally devolved on the pike-perches, the name *Lucioperca*. This they did in the following manner:

Des Sandres (*Lucioperca*, nob.).

Ce sous-genre se distingue des autres par la réunion qu'il présente des nageoires et des préopercules de la perche, avec des dents pointues qui rappellant celles du brochet, et c'est qui a fait donner, par Conrad Gesner, à l'espèce d'Europe le nom composé de *lucioperca* (*brochet-perche*).‡

The history thus detailed is summarized in the following synonymy:

STIZOSTEDION.

Synonymy.

=*Les Sandres*, CUVIER, Règne Animal, vol. 2, p. 294, 1817.
=*Stizostedion*, RAFINESQUE, West. Mag. and Misc. Mag., vol. 1, p. 371, Jan. 1820; Ich. Oh., p. 23, 1820.
=*Lucioperca*, FLEMING, Phil. of Zool., p. 394, 1822.
=*Sandat*, CLOQUET, Dict. Sc. Nat., vol. 47, p. 173, 1827.
=*Sandrus*, STARK, Elem. Nat. Hist., vol. 1, p. 465, 1828.
=*Lucioperca*, CUVIER and VALENCIENNES, Hist. Nat. Poissons, vol. 2, p. 110, 1828.
=*Schilus*, KRYNICKI, Nouv. Mém. Soc. Nat. Moscou, vol. 2, p. 441, 1832.
=*Centropomus*, BLEEKER, Arch. Néerland. Sc., vol. 11, p. 265, 1876. (Vix *Centropomus* Lacépède, 1801.)
=*Stizostethium*, JORDAN, Cont. to N. Am. Ich., II, p. 43, 1877.
=*Stizostedium*, JORDAN and GILBERT, Syn. Fishes N. Am., p. 525, 1882.

Subgenera.

<*Cynoperca*, GILL and JORDAN, Jordan's Cont. to N. Am. Ich., II, p. 45, 1877.
<*Stizostethium*, GILL and JORDAN, Jordan's Cont. to N. Am. Ich., II, p. 45, 1877.
<*Lucioperca*, GILL and JORDAN, Jordan's Cont. to N. Am. Ich., II, p. 45, 1877.
<*Mimoperca*, GILL and JORDAN, Jordan's Cont. to N. Am. Ich., II, p, 45, 1877.

* Gen. 75 of Acanthopterygii.
† Histoire Naturelle des Poisson, vol. 2, p. 110.
‡ Gesn., *Paralip.*, p. 28 et 29.

DESCRIPTION OF A NEW SPECIES OF COTTON RAT (SIGMODON MINIMA) FROM NEW MEXICO.

By Edgar A. Mearns, M. D.,
Surgeon, United States Army.

Among the small mammals collected by Mr. F. X. Holzner and myself on the Mexican border, in connection with the operations of the International Boundary Commission, are two specimens of a species of cotton rat, which, in my opinion, is distinct from any heretofore described.

In the grassy hollows and flats between the most southern spurs of the Apache Mountains, in an arid, treeless region, having an altitude of 1,500 metres (exactly 1,496 at the monument), it was a surprise to find any species of *Sigmodon*. Many of their old runways were seen, however, in the dry and dusty grass; but nearly all of the holes were abandoned. Industrious trapping, persisted in for several weeks, resulted in the capture of but two adult male specimens. Mexican miners in the vicinity told us that only a few months before the species had been abundant, but seemed to have died off; indeed, we frequently saw their remains in the grass and picked up parts of skeletons and one or two additional skulls.

This new species has many points in common with *Sigmodon fulviventer*, recently described by Dr. J. A. Allen, from Zacatecas, Mexico.* It is still smaller than that species, being about the size of De Saussure's "*Hesperomys toltecus*" (=*Sigmodon hispidus toltecus*).† On capturing these specimens I was at once struck by their resemblance to *S. fulviventer*, the type of which I had closely examined in the American Museum of Natural History in New York, the resemblance consisting not only in the fulvous tone of coloring, especially of the under parts, but in the distinctly bristly character of the hairy coat and the dense hairiness of the ears and tail, in all of which particulars it differs

* Bull. Amer. Mus. Nat. Hist., II, No. 3, p. 180, October 21, 1889.
† Allen. *L. c.*, III, 1891, p. 207.

* Proceedings National Museum, Vol. XVII—No. 994.

radically from its geographically nearest neighbors—*Sigmodon hispidus texianus*, (Aud. and Bach.) and *S. hispidus arizonæ*, (Mearns).

SIGMODON MINIMA, new species.

Type.—No. 21187, U. S. N. M. (Coll. International Boundary Commission). Adult male, from Upper Corner Monument, New Mexico, on the Mexican boundary line, 100 miles west of the initial monument on the west bank of the Rio Grande. Collected by Edgar A. Mearns and Frank X. Holzner, April 26, 1892.

Description of type.—Coat bushy and hispid; under-fur darker plumbeous than in *S. hispidus texianus* or *S. hispidus arizonæ*; coarse outer coat more bristly, especially on sides of head and neck; ears, feet, and tail densely hairy; tail not distinctly bicolor. Color above grayish, the individual hairs being ringed with gray and brown, the brown annuli being blackish in their middle portion, fading to light-yellowish brown on their edges; under surface of body clayey buff; feet yellowish gray; ears densely clothed with grayish hairs on inner surface, with their convex surface black anteriorly and buff posteriorly; tail brownish black, somewhat lighter below, the hairs almost concealing the annuli.

Another specimen (No. 1760, male adult, from the same locality, collected by Mearns and Holzner, May 13, 1892) differs only in being ochraceous buff below, with a little more of the fulvous tinge on rump and flanks, thus approaching more closely to the coloration of *Sigmodon fulviventer*.

Dimensions.—Measurements (in millimeters) of No. 21187, adult male: Length, measured from nose to end of vertebræ of tail, 223; tail, measured from root to end of vertebræ, 94; to end of hairs, 104; height of ear above crown, 14; distance between eyes, 12; diameter of eye, 5; length of longest whisker, 30; from tip of nose to eye, 16; to center of pupil, 18.5; to ear, 30; to tip of ear, 46; to occiput, 37; to end of outstretched hind limb, 183; fore limb, measured from olecranon to end of longest claw, 33; length of fore-foot, 15; longest claw of fore-foot (chord), 3.9; hind limb, measured from knee-joint to end of longest claw, 53; length of hind-foot, 28; longest claw of hind-foot, 3 mm. Measurements of No. 1760, adult male: Length, 223; tail to end of vetebræ, 91; to end of hairs, 97; height of ear above crown, 12; above notch, 16; distance between eyes, 12; diameter of eye, 5; longest whisker, 26; from top of nose to eye, 16; to center of pupil, 19; to ear, 30; to tip of ear, 46; to occiput, 34; to end of hinder extremity, 180; fore limb from olecranon, 33; length of fore-foot, 14; longest claw of fore-foot, 3; hind limb from knee-joint, 53; length of hind-foot, 27; longest claw of hind-foot, 4.2 mm.

Cranial and dental characters.—As compared with *S. hispidus texianus*, the only species before me for comparison, the brain-case is higher and narrower, the skull more constricted between the orbits, with shorter nasals, their bases being nearly even with the posterior border of the incisive foramen instead of well behind it. The dentition is very much heavier.

NOTES ON THE INVERTEBRATE FAUNA OF THE DAKOTA FORMATION, WITH DESCRIPTIONS OF NEW MOLLUSCAN FORMS.

[With plate VIII.]

By Charles A. White,

Honorary Curator of Mesozoic Invertebrate Fossils.

Although the Dakota formation is of great geographical extent, and, stratigraphically, one of the most clearly defined of the divisions of the North American Upper Cretaceous, comparatively little is known of its contemporary fauna. Of its flora, however, which is a great and varied one, much more is known, and remains of its numerous specific forms are generally used in the paleontological characterization of the formation. Those remains consist largely of angiospermous leaves, and a greater or less number of species have been found in all the districts where the formation has been recognized.*

The discovery of vertebrate remains in Dakota strata was, some years ago, publically announced, but it has since been ascertained that they came from the underlying Jurassic strata. It is, therefore, not yet certain that remains of land animals of any kind have been found within the proper limits of this formation, which fact, in view of the evidence we have of the contemporaneous prevalence of a great and varied land flora, is quite remarkable.

Notwithstanding the great geographical extent of the Dakota formation, only three discoveries of invertebrate remains have, so far as I am aware, been made in its strata. The first of these discoveries was made by Dr. F. V. Hayden in the valley of the Missouri River, at a few localities within a small district which embraces the mouth of the Big Sioux River. The second discovery was made by Prof. B. F. Mudge in Saline County, Kansas, and the third by Prof. L. E. Hicks in Jefferson County, Nebraska.

Those which were discovered by Dr. Hayden are described and figured by Mr. F. B. Meek in Volume IX of the U. S. Geological Survey

*See The Flora of the Dakota Group, by Leo Lesquereux; Monog. XVII, U. S. Geological Survey. Washington: Government Printing Office, 1891. This is a posthumous publication, edited by Prof. F. H. Knowlton.

of the Territories. A part of those discovered by Prof. Mudge are described and figured by Mr. Meek in the volume just mentioned, and a part of them by myself in volume II of the Proceedings of the U. S. National Museum. Those which were discovered by Prof. Hicks are described and figured in this article.

Prof. Hicks made his collection about ten years ago and deposited it in the cabinet of the Nebraska State University in 1885. In that year he referred to it in a paper which he read before the American Association for the Advancement of Science as representing a marine fauna,* but further study showed it to have been of nonmarine origin. The following description of the locality at which Prof. Hicks discovered these fossils has been given me by him:

Jefferson County, Nebraska, 5 miles west of north from Fairbury, about 1 mile from the Little Blue River. The exposure is a comparatively slight one and occurs upon the north side of a deep ravine, about half way up the slope. This ravine opens into Whiskey Run, and the latter empties into Little Blue River.

The Dakota strata at this locality, as is usually the case in all that district, consists of ferruginous sandstone, the fossiliferous layers consisting largely of impure, partly oolitic, limonite. Fragments and masses of these layers constitute the collection made by Prof. Hicks. These specimens contain an abundance of fossil remains, all of which are either vegetal or molluscan, and all are in the condition of natural casts, molds, or imprints. All the molluscan forms which have been recognized are described and figured on following pages. The plant remains embrace well-known Dakota species. The following have been identified by Prof. F. H. Knowlton, the editor of Lesquereux's work on the Dakota flora, already referred to: *Salix meekii*, Newberry, *Diospyrus primæva*, Heer, *Sapindus diversifolius*, Lesquereux, *Magnolia* ———? (probably new), *Platanus primæva*, Lesquereux.

All the specimens of the collection being in the condition of natural casts, imprints, and molds, the greater part of the studies recorded on the following pages, and all the figures on the accompanying plates, have been made from artificial casts taken from the natural molds. Because of this condition of the specimens the studies of all the species which they represent have been far from complete. So much interest, however, naturally attaches to the division of the Dakota fauna which they represent that, notwithstanding their imperfection, I have thought it desirable to publish them. I have also thought it desirable to give a specific name to each form for purposes of convenience in geological studies, rather than as indicating a satisfactory biological classification.

I am indebted to the authorities of the Nebraska State University, through Prof. Erwin H. Barbour, for the opportunity to study and publish this small but interesting collection. All the specimens used in this study are returned to the cabinet of the University at Lincoln,

*Proc. A. A. A. S., vol. 34, pp. 217-219.

together with the artificial casts used in the preparation of the descriptions and figures. A duplicate set of these casts, however, is deposited in the U. S. National Museum at Washington.

Class CONCHIFERA.

Family UNIONIDÆ.

UNIO BARBOURI, new species.

Plate VIII, Figs. 1, 2, 3.

Shell elongate-subelliptical, as viewed laterally, narrowly subelliptical, as viewed vertically, and ovoid as viewed in front. Dorsal margin gently convex, abruptly rounded to the front margin; the latter margin gradually rounded to the broadly convex basal margin; posterior margin abruptly rounded or subangular, its most prominent part being above the midheight of the shell; beaks not prominent, situated near the front, but they are not so nearly terminal as is often the case with Cretaceous species of *Unio*. Cardinal teeth moderately small; lateral teeth slender; postero-dorsal ridge of each valve slightly prominent and ending, as usual, at the most prominent part of the posterior margin. Surface marked by the ordinary lines and imbrications of growth.

Length, when perfect, of the principal specimen from which the foregoing description is drawn, about 75 mm; height, 35 mm; convexity, 25 mm.

All the known specimens of this species being in the condition of natural molds of the exterior and casts of the interior, the foregoing description, and also the figures illustrating it, have been made from the natural casts and from artificial casts taken from the natural molds.

One of the artificial casts shows that the beaks had become considerably eroded, a condition extremely common in the case of living species of *Unio* in the waters of the Mississippi drainage system, but quite uncommon among North American fossil species of *Unio*.

This species has the general shape and aspect of the living *Unio anodontoides* Lea, of the Mississippi drainage system, and it is in all respects a modern type of *Unio*. Indeed, it so nearly resembles some individual varieties of the species just mentioned that it is difficult to choose words which shall diagnose it as specifically different. Still, I think it inexpedient, even from a biological point of view, to apply the name of any living species to a Cretaceous form and, that from a geological point of view, it is especially undesirable to do so.

I have chosen the specific name of this form in honor of Prof. Erwin H. Barbour. of the Nebraska State University.

UNIO, doubtful species.

Plate VIII, figs. 4, 5.

The collection made by Prof. Hicks contains an internal cast of a small specimen of *Unio*, probably a young example, which differs too much

in form and proportions from the one just described to allow its reference to that species. Indeed, it differs so much from the other that it seems to belong to the type of *Unio alatus*, Say. Still, the specimen is too imperfect to allow of a satisfactory specific description, but it is figured on plate VIII for the purpose of giving as complete a representation as possible of the meager fauna of the Dakota formation, as it is now known.

Family CORBULIDÆ.

CORBULA HICKSII, new species.

Plate VIII, figs. 6, 7, 8.

Shell of medium size, elongate-subtrihedral in marginal outline; posterior end prominent and narrow; valves of moderate convexity, not strongly unequal; beaks high and narrow and turning forward; basal margin broadly convex; posterior margin narrowly rounded; postero-dorsal margin slightly convex and sloping downward from between the beaks to the narrow posterior end; front margin regularly rounded from the basal margin to the inter-umbonal space; surface marked by the usual distinct lines of growth; hinge having the typical characteristics of *Corbula*.

Length of the largest example in the collection, which is a left valve, 26 mm; height from base to umbo, 16 mm; convexity of the single valve, 6 mm.

The collection contains an abundance of specimens of this species, all of which are in the condition of natural molds and casts. The foregoing description has been made from those molds and casts and from artificial casts taken from some of the natural molds. The figures on plate VIII are drawn from artificial casts.

This form is of the same general type as that of the Laramie *Corbula* to which Mr. Meek gave the name *C. crassitelliformis*, but it is somewhat more gibbous and also broader in front. The specific name is given in honor of Prof. L. E. Hicks, its discoverer.

Class GASTEROPODA.

Family CERIPHASIIDÆ.

GONIOBASIS JEFFERSONENSIS, new species.

Plate VIII, fig. 9.

Shell small, slender, sides of the spire approximately straight; volutions apparently about 10 in number, gradually increasing in size from the apex to the front; sides of the volutions nearly straight or flat, thus forming the nearly straight sides of the spire; suture linear; surface nearly or quite smooth.

Length of the only specimen discovered, 13 mm; breadth of the last volution, 5 mm.

This species is represented by only a single, somewhat imperfect, natural mold of the exterior of the shell, and which does not show the character of the aperture. It is therefore referred to *Goniobasis* because of its external form and features. It bears a general resemblance to *G. macilenta* White, of the Bear River formation, but it differs in lacking certain of the surface markings of that species.

GONIOBASIS, doubtful species.

Plate VIII, fig. 10.

Another specimen, evidently referable to *Goniobasis*, was found associated with the foregoing. It resembles that species in certain respects, but the apical angle is considerably greater and the shell is therefore less slender. It possibly belongs to the same species with the foregoing, but I am inclined to regard it as representing another form.

Family MELANIIDÆ.

PYRGULIFERA MEEKIII, new species.

Plate, VIII, fig. 13.

The collection contains a single specimen, in the condition of a natural mold, which I have little, if any, doubt represents a species of *Pyrgulifera*. The form and character of the aperture are not shown, but the surface features agree well with those of typical species of that genus, and they are much like those of some individual varieties of *P. humerosa* which were found by Mr. T. W. Stanton in western Wyoming. The volutions, however, are more regularly convex, and the revolving lines finer and more numerous than I have found them to be on any specimens of *P. humerosa*. I therefore give it a new specific name, selecting that of the founder of the genus.

The discovery of *Pyrgulifera* in the Dakota formation is of special interest, not only because that genus has not hitherto been found in any other North American formation than the Bear River, but because that formation is believed to be of nearly, if not quite, the same age as the Dakota.

Family VIVIPARIDÆ.

VIVIPARUS HICKSII, new species.

Plate VIII, figs. 11, 12.

The collection contains three or four imperfect natural molds of a small species of *Viviparus*, artificial casts of two of which are figured on plate VIII. The species is a little more elongate, and the spire more acute, than is usual with *Viviparus*, but a portion of the aperture shown by one of the specimens indicates that it was like that of typical forms of that genus.

Concluding remarks.—It is true that the collection of invertebrate fossils described in this article does not add materially to our knowledge of biological forms, but in several respects it possesses unusual interest. It is, as has already been mentioned, one of only three collections of invertebrate remains that have been made from the Dakota formation, the strata of which we have abundant evidence to believe originally occupied many thousands of square miles. It indicates more distinctly than any previously discovered facts have done, the nonmarine character of that formation. It embraces four genera which have never before been recognized in collections from its strata. Although that formation lies at the base of the Upper Cretaceous series, a majority of the species which this collection contains belong to genera representatives of which are among the characteristic members of the molluscan fauna now living in the waters of the Mississippi drainage system.

Of the few species that were discovered by Dr. Hayden a part belong to genera which are generally regarded as indicating a marine habitat, a part are such forms as usually inhabit estuarine or other brackish waters, and one was referred by Mr. Meek, who described these fossils,* to the genus *Margaritana*. I have no reason to doubt that this species belongs to the Unionidæ, but the type specimens do not satisfactorily show the hinge structure and other features upon the modification of which the different genera of that family are established.

Dr. Hayden did not find the forms which have just been mentioned as indicating a marine habitat in immediate association with the shell which Mr. Meek referred to *Margaritana*, its only associate having been a form which he referred to *Cyrena*. According to our present knowledge of the habitat of the different molluscan genera the association of *Margaritana* and *Cyrena* is incongruous, because the former genus is never found living in saline waters, and the latter never in fresh. I think, however, that the shell referred to *Cyrena* by Mr. Meek may be properly referred to *Corbicula*, the shell characteristics of which genus are so nearly like those of *Cyrena* that it is often difficult or impossible to diagnose them as different in the fossil condition. Species of *Corbicula* are not unfrequently found living in fresh waters, and we have abundant evidence that fossil, if not living, forms of *Unio* and *Corbicula* lived and thrived together. I therefore regard it as reasonable to infer that the Dakota strata in which the two species referred to were discovered were deposited in fresh, or at most, in brackish waters. The discovery of remains of a couple of species of characteristic Dakota plants commingled with these fossil molluscan forms leaves little or no room for question as to the Dakota age of those strata. I have also little doubt that the layers from which came the other molluscan forms discovered by Dr. Hayden in the district just mentioned are near the

* For descriptions and figures of these species, see Vol. IX, U. S. Geol. Surv. Terr., pl. 1, pp. 92, 114, 159, 206, 251.

top of the formation, and that they lived in waters which were then changing to the marine condition which prevailed during the succeeding Colorado epoch.*

The invertebrate species collected by Prof. Mudge in Saline County, Kans., consist wholly of forms which are regarded as indicating a marine habitat, but they are all such as are generally understood to indicate a littoral, or at least a shallow-water, condition. They were described by Mr. Meek and myself, respectively.† I have never personally examined the stratigraphy of Saline County, Kans., but I accepted Prof. Mudge's identification of the Dakota formation there when I published the description of the species referred to, and I have since expressed the opinion that the formation changes from a nonmarine to a marine condition in its southward and southeastward extension.‡

Although the generic characteristics of all the forms contained in the collection of Prof. Hicks are not well shown by the specimens, I have no reason to doubt the generic identity of any of them as indicated by the names applied to them respectively in the foregoing descriptions. I therefore regard the collection as unmistakably indicating a nonmarine origin for the strata from which it was made. Indeed, I think the character of the collection as a whole indicates a purely fresh-water origin. This opinion is supported by the following facts: Of the five genera represented in the collection, representatives of three of them, namely, *Unio*, *Goniobasis*, and *Viviparus*, have never been found living in any other than fresh waters. It is true that species of *Corbula* are usually found in saline waters, and often in those of full marine saltness; but it is also true that living species of that genus sometimes range into fresh waters, and the fossil species have frequently been found associated with *Unio*, *Goniobasis*, and *Viviparus*. The fossil faunal associates of *Pyrgulifera* usually indicate a brackish-water condition, but the type species of the genus, while sometimes found commingled with shells of *Ostrea*, is oftener found associated with such fresh-water forms as *Unio*, *Viviparus*, *Campeloma*, etc. Moreover, the only known living species of the genus inhabit fresh waters.

The general prevalence of land plants in the strata of the Dakota formation is also an indication of its nonmarine origin, as is the general absence of marine remains. Indeed, the only discoveries of fossil remains in Dakota strata which indicate a saline condition of the waters in which they were deposited were made along a part of, or near, the eastern border of the formation.

I do not think it is fully proved that the bulk of that portion of the formation which occurs in the Missouri River valley in the vicinity of

* These remarks are based upon my recollection of a personal statement made to me by Dr. Hayden.

†Vol. IX, U. S. Geol. Surv. Terr., pl. 2, pp. 80, 92, 109, 120, 163, 164, 170, 174, 195, 202, 253, 300, and 333; Proc. U. S. Nat. Museum, vol. 2, pl. 5, pp. 295, 296.

‡See Bull. U. S. Geol. Survey, No. 82, p. 122.

the mouth of the Big Sioux River was deposited in saline waters, but there is no reason for questioning the marine origin of the collections made by Prof. Mudge in Saline County, Kans. I have no reason to doubt that the Kansas deposit holds the same stratigraphical position in the Cretaceous series as does the Dakota formation, nor do I know of any reason to doubt that it merges horizontally into the Dakota. Still, I am disposed to exclude those Kansas deposits and their southern and southeastern marine equivalents, when discussing the fauna of the Dakota formation proper. Indeed, I think it is to be expected that should any invertebrate remains be found in any of the Dakota strata which are known to prevail in the great region westward and northwestward from eastern Kansas and Nebraska, they will be such as indicate a fresh-water habitat.

EXPLANATION OF PLATE VIII.

Unio barbouri, p. 133.

Fig. 1. Side view of an artificial cast from a natural mold.
Fig. 2. Dorsal view of the same specimen.
Fig. 3. Side view of an artificial mold of a natural cast of a right valve of another specimen of the same species.

Unio (doubtful species), p. 133.

Fig. 4. Side view of a natural cast of the interior of the shell.
Fig. 5. Dorsal view of the same specimen.

Corbula hicksii, p. 134.

Fig. 6. Side view of the left valve; an artificial cast from a natural mold.
Fig. 7. Dorsal view of the same specimen.
Fig. 8. Front view of another specimen; also an artificial cast of a natural mold.

Goniobasis jeffersonensis, p. 134.

Fig. 9. Side view of an artificial cast of a natural mold.

Goniobasis (doubtful species), p. 135.

Fig 10. Side view of an artificial cast of a natural mold.

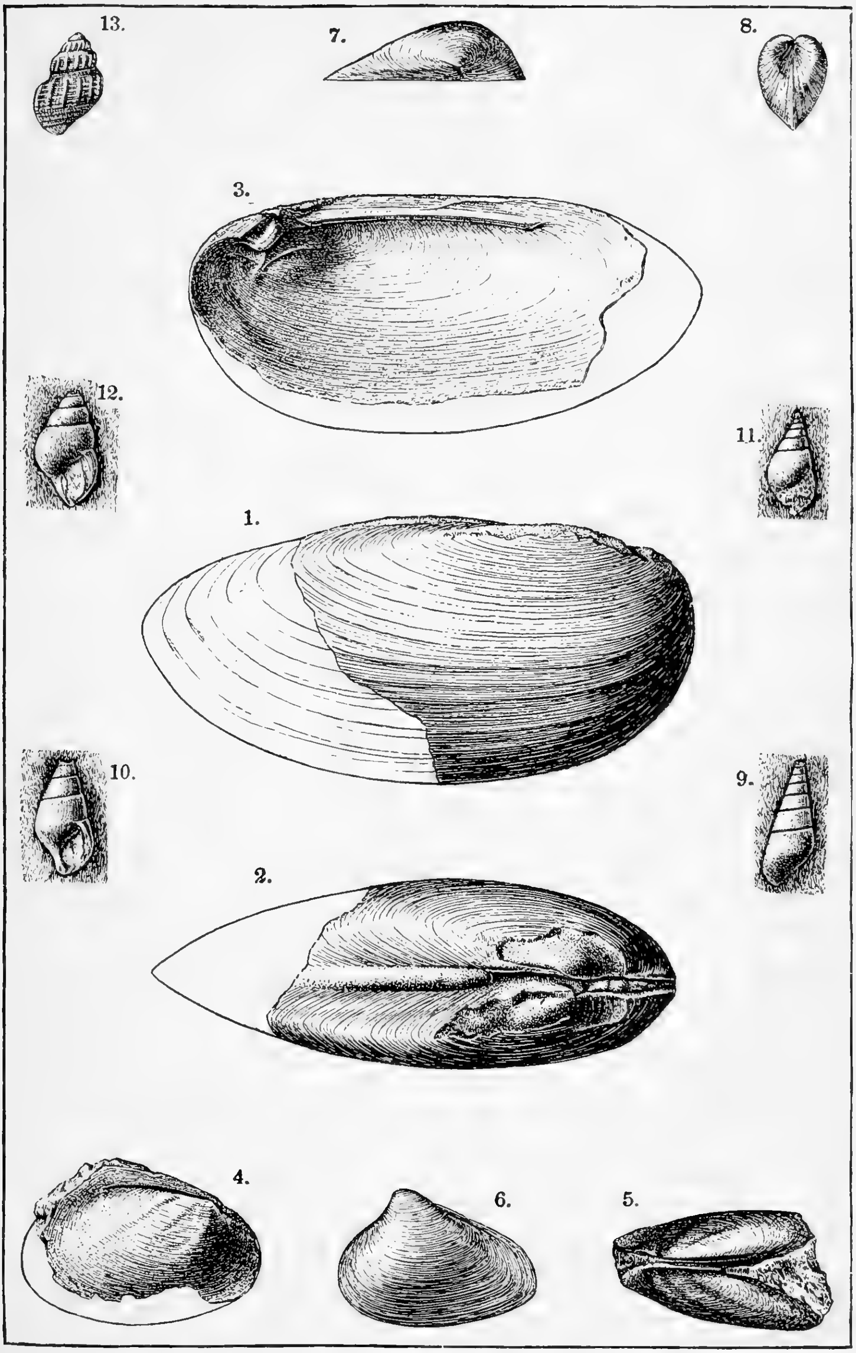
Viviparus hicksii, p. 135.

Fig. 11. Side view of an artificial cast of a natural mold.
Fig. 12. Side view of another similar cast.

Pyrgulifera meekii, p. 135.

Fig. 13. Side view of an artificial cast of a natural mold.

All the figures on this plate are of natural size except fig. 9, which is slightly enlarged.



FRESH-WATER MOLLUSKS OF THE DAKOTA FORMATION.

THE SHELLS OF THE TRES MARIAS AND OTHER LOCALITIES ALONG THE SHORES OF LOWER CALIFORNIA AND THE GULF OF CALIFORNIA.

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In the spring of 1876, Mr. W. J. Fisher, of San Francisco, who had previously, in 1873, been connected as Naturalist with the U. S. S. *Tuscarora* Telegraph Sounding Expedition, under Commander George E. Belknap, conceived the idea of chartering or purchasing a small vessel and making an investigation of the shores and islands of Lower California and the Gulf of California in the interest of natural history. Through the generosity of Mr. Fisher, the greater part of the mollusks collected by him were given to me, and became a part of the Stearns Collection, now incorporated into the greater collection of the U. S. National Museum.

Mr. Fisher's collection, though made, as it will be seen, many years ago, has not heretofore been brought to notice. Notwithstanding this lapse of time, its value, through the importance of the information it furnishes on the geographical distribution of most of the species enumerated, has not been impaired by delay in publication, as no subsequent collector has touched at or visited so many localities around the shores of the Gulf and of Lower California, or if any such collection has been made it has not been made known. Many of the localities have not previously been mentioned, either by collectors or authors. The importance of Mr. Fisher's collection, in its bearing upon the Mollusca of the Tres Marias, is worthy of special mention; it would of itself justify the publication of the list, for it exhibits more fully the mollusk-fauna of this interesting and little-known group of islands, and includes a greater number of species than any and all previous publications. Aside from the few new species that he collected, much light was obtained as to others that may be regarded as rare or little known, and again, the detection of so many familiar forms, heretofore associated in our minds with Indo-Pacific or rather Polynesian waters, is almost a revelation and of exceeding interest. There are no currents setting eastward from

the Pacific that might possibly transport drift material from the regions where these species are known to live, and thus convey and enable them to make a lodgment or gain a foothold on the western coast of the continent. In the gulf region the currents sweep in the opposite direction, that is, to the westward. It is possible that these exotic forms have been introduced as an incident of commerce.

For many years vessels seeking a return cargo from various places in Indo-Pacific waters have visited the gulf region, especially the Tres Marias islands, for the dyewoods that are found there, and which at various periods have furnished quite a large business to vessels seeking return freights. Vessels bound to the gulf ports in such cases would be in ballast, and if from Indo-Pacific regions the ballast would, it is probable, consist in the main of coral blocks or fragments of reef-rock, the chinks of which ordinarily furnish a hiding place for molluscan species, and other small forms of marine life. Upon arriving at the port or embarcadero before loading, the ballast would be dumped overboard, and with it such animals, living or dead, as were secreted among, attached to, or contained in it. The Tres Marias and Altata are well known loading places for the dyewoods trade; the latter being an embarcadero for interior regions, where the dyewoods are cut. In one instance I collected several specimens of *Orthalicus undatus* and a species of *Bulimulus* that had concealed themselves among the dyewood and were transported with it to San Francisco. Upon discharging the cargo, in throwing the freight ashore, the snails were jarred out. Some of them were picked up on the wharf and others in the hold of the vessel after the cargo was discharged.

Besides the dyewoods, salt from the Carmen Island works and orchilla furnish export cargoes in whole or in part. The extent of the traffic in these Mexican exports varies very much one year or period compared with another. At the time of the Franco-Mexican war, or rather the invasion of Mexico by the French, the commerce of the gulf was greatly increased. It was during this period that large and important additions were made to the Stearns Collection, through arrangements made with parties employed in the coastwise trade between California and west Mexican ports. No such opportunity for obtaining the shells of the gulf region has occurred since, nor is likely to for many years. In addition to the collection made by Mr. Fisher, I have, in a few instances, added to the list localities visited by other friends and the species collected by them. In this connection, the names of Capt. A. Forrer, of Dr. William M. Gabb, whose collections, made at San Juanico and Loreto, Lower California, in February, 1867, were published by me in 1873,* and the late Henry Edwards, well known as an excellent actor and in scientific circles as an accomplished entomologist and writer on entomological subjects, who contributed a few species that were found by him at Mazatlan and vicinity in 1873, appear occasion-

* Proc. Cal. Acad. Sciences, July, 1872.

ally, and the names of other friends—Mr. J. W. Towne, of San Francisco, Samuel Pillsbury, Henry W. Henshaw, and Henry Hemphill occur. The latter, as well as Mr. L. Belding, of California, and Dr. Edward Palmer, have added many species and examples of interest and importance to the national collection.

All of the species credited to San Juanico, on the outer coast of the peninsula, and Loreto were collected by Dr. Gabb. All of those referred to Altata were presented by Mr. A. J. Gove, of San Francisco, who received them directly from the parties who collected them at the locality stated. With a few exceptions, all of the species herein listed are contained in the National Museum, having formed a part of the Stearns Collection. This list is, however, not quite complete. There are several species, notably of *Chitons*, not yet determined, that should be added, and doubtless a few small species may ultimately be found in the general collection that were collected by Mr. Fisher and have been overlooked, for the department of mollusks in the National Museum has reached such vast proportions, the registered numbers already exceeding 126,000 trays, that omissions are likely to occur in a paper of this character, through want of time to make a critical examination and revision.

The latitude and longitude of the various localities referred to are given below, commencing at the Coronado Islands, the most northerly on the ocean side, off the peninsula of Lower California, and proceeding southerly to Cape St. Lucas; thence northerly along the western shore of the Gulf of California, including the islands; thence along the eastern shore of the gulf, following the same and the mainland along the Mexican coast to the last or most southerly locality, Acapulco, in latitude 16° 55′.

In my lists of the shells collected at San Juanico and Loreto by Dr. Gabb, heretofore mentioned, I referred to San Juanico as being "on the east side of the peninsula of Lower California in latitude 27° north." This was an error occasioned by my following the localities as given in Prof. C. B. Adams' list of the "Shells of Panama;" and due no doubt to the fact of there being two places, one on each side of the peninsula of the same name. To prevent mistakes, I have listed the San Juanico of the eastern side as Point San Juanico (see San Juanico Cove). In connection with Boca de los Piedras, frequently referred to, see Estera de los Piedras in the list of localities.

Delays due to various causes have enabled me to add the collections made by the *Albatross* naturalists, Prof. Leslie A. Lee and his assistants, in 1887–'88 at Ballenas and Pichilinque bays, etc., so far as the same have been worked up at this date.

Several species of land shells inhabiting the Gulf region are included in this paper; for further information, relating to those of Lower California more particularly, attention is called to Dr. Cooper's three papers "On Land and Fresh-water Mollusca of Lower California," in Vol. III of

the Proc. Calif. Acad. Sciences, also an article in *Zoe*, April, 1892, and to the more recent paper by Mr. Dall on the "Land Shells of the Genus Bulimulus in Lower California," etc.

In this connection see the titles of various publications at the close of this paper.

Localities.

Lower California, western or ocean shore from vicinity of San Diego to Cape St. Lucas:

Locality.	Lat. N.	Long. W.
	° ′	° ′
Coronado Islands	32 25	117 15
Todos Santos Bay	31 50	116 40
San Tomas	31 33	116 42
San Quentin Bay	30 24	115 55
Guadeloupe Island	29 00	118 20
Cerros or Cedros Island	28 10	115 15
Assuncion Island	27 06	114 18
Ballenas Bay	26 45	113 25
San Juanico	26 04	112 17
Santa Maria Bay	24 45	112 13
Magdalena Bay	24 35	112 00
Margarita Bay	24 25	111 40
Cape St. Lucas	22 52	109 55

Lower California, gulf side of peninsula and islands, from Cape St. Lucas northerly.

Locality.	Lat. N.	Long. W.
	° ′	° ′
La Paz	24 10	110 20
Pichilinque Island	24 16	110 21
San Josef Island	25 00	110 40
Port Escondido	25 49	111 19
Loreto	26 00	111 21
Carmen Island	26 00	111 09
San Bruno	26 12	111 23
San Juanico Cove	26 22	111 26
Mulege Bay (anchorage)	26 54	111 58
San Lucas Cove	27 12	112 13
San Marcos Island	27 13	112 05
San Carlos Bay	27 51	112 47
San Juan Bay	28 02	112 49
San Francisquita Bay	28 26	112 53
Los Animas Bay	28 50	113 20
Angeles Bay	28 55	113 32
Puerto Refugio north end of Angel de la Guardia Island	29 33	113 34
San Luis Island	29 58	114 25

Gulf of California, eastern or main shore, and islands southerly to Acapulco on the Pacific Ocean.

Locality.	Lat. N.	Long. W.
	° ′	° ′
Guaymas	27 55	110 53
River Yaqui, mouth	27 37	119 40
Estero de los Piedras	25 50	109 25
Altata	24 38	107 57
Mazatlan	23 11	106 26
San Blas	22 50	105 30
Tres Marias	21 25	106 25
Manzanillo	19 00	104 30
Socorro Island	18 48	111 00
Acapulco	16 55	100 00

The islands constituting the Tres Marias group are known as the Maria Madre, the San Juanita, the Maria Magdalene, and the Maria Cleofas, the Maria Madre being the largest. They are situated due west of San Blas, and "consist of stratified rocks," separated from the mainland "by a flat of not more than * thirty fathoms" in depth.

All or nearly all of the forms credited to this group are from Maria Madre; or if collected upon the others, the fact has not been stated by Fisher, or the other collectors as far as I am aware.

Of Socorro, the principal island of the more distant Revilla-Gigedo group, we know but little or nothing. It was visited several years ago by Grayson, the ornithologist. The few marine shells that have been brought from there, are as would be supposed, familiar gulf forms. Of the land shells nothing is known. These islands are situated in comparatively deep water, according to the *Albatross*, soundings from 1,500 to 1,800 fathoms.

Class PELECYPODA.

Family OSTREIDÆ.

OSTREA PALMULA, Carpenter.

Rare (No. 74809, U. S. N. M.). Pond's Island southern point of Angeles Island, Gulf of California, Fisher; La Paz A. Forrer.

This species is number 357 in Carpenter's Check-list of the Smithsonian Institution, and in the "Mazatlan Mollusca," number "214 *b:* Ostræa?? *conchaphila*, var. *palmula*."

Judging from Carpenter's description in his Mazatlan shells, the Fisher and Forrer examples belong to his species. The specimen before me is much larger than the measurement given by Carpenter, and the proportions are not the same; as oysters vary so much in this respect, the individuals of one colony compared with the individuals of another, this discrepancy may be allowed to pass without further comment.

The chief example (Fisher's) measures 3·56 by 3·48 inches, a fine specimen.

The Forrer specimen which is a thick, solid shell shows 2 inches in greatest length by $1\frac{1}{4}$ inches in width.

Carpenter gives the proportions and size of his type, as "long. 2·3, lat. 1·6 [height]." He says "remarkable for the palmated foliations on the outer margin, * * * and for the row of denticles within this limb and within the nacreous border, fitting into corresponding depressions in the other valve." The palmated foliations radiate from just beneath the cartilage in the under or lower valve to the margin. In the upper valve these radiating ribs commence at a point about one-third of the distance from the umbo; perhaps in a large number of examples, some might exhibit this character as extending to the umbos.

* A. Agassiz.

In the specimen before me, which resembles a large *Plicatula*, there are from 19 to 20 of these ribs; these are sharply angulated and interlock closely at the margin of the valves. For an oyster this is a well marked species; it suggests Hanley's *Ostrea megadon*.

Family Anomiidæ.

PLACUNANOMIA CUMINGII, Broderip.

One perfect example.

Off Lower California, at Station 2827; shelly bottom, in 10 fathoms; *Albatross*.

Family Spondylidæ.

SPONDYLUS PRINCEPS, Broderip.

Several examples, and odd valves.

Pichilinque Bay; also at Station 2828, off Lower California, in 10 fathoms; *Albatross*. The various colors exhibited by the shells of this beautiful species are included in the collections at above places.

Family Pectenidæ.

PECTEN SUBNODOSUS, Sowerby.

Loreto; Scammon's Lagoon (No. 105625, U. S. N. M.), Hemphill; Carmen Island (No. 63647, U. S. N. M.), Towne. Examples of this fine, though not very rare species, frequently occur, that are neither nodose or subnodose. Hemphill found it living on mud flats.

Pichilinque Bay (two odd valves), *Albatross;* also at Station 2827 (No. 102091, U. S. N. M.) and Station 2826, 10 fathoms (No. 102088. U. S. N. M.); in 9½ fathoms, off Lower California.

PECTEN VENTRICOSUS, Sowerby.

Several examples.

Pichilinque Bay, one good specimen, beach; Sta. Margarita Island (one valve); Station 2828, 10 fathoms, off Lower California; all *Albatross*.

PECTEN (JANIRA) DENTATA, Sowerby.

Several examples.

San Juanico; St. Luis Bay; Guaymas, Palmer (No. 12508, U. S. N. M.), Ballenas Bay (concave valve), and one good specimen at Station 2828, off Lower California, in 10 fathoms; *Albatross*.

Family Aviculidæ.

AVICULA PERUVIANA, Reeve.

One pair valves; beach. Sta. Margarita Island.

MARGARITIPHORA FIMBRIATA, Dunker.

Valves only.

Pichilinque Bay; Station 2828, 10 fathoms, off Lower California; *Albatross.*

PERNA JANUS, Carpenter.

Several examples.

La Paz, both Fisher and Forrer (No. 73560, U. S. N. M.).

I have three well-marked specimens before me, which agree with Dr. Carpenter's description in the Mazatlan catalogue, pp. 151,152. The description says: "The sculpture of the valves, of which the under is smooth, the upper ornamented with fine, radiating striæ, etc.;" two of the specimens, however, show the radiating striæ on both valves. Carpenter gives the measurement of his "the largest, long. (the diagonal of the lozenge) 1.12; lat. 0.68, etc." inch.

My largest example (Fisher's) measured in the same way, gives the following: Length, 2.25; breadth, 1.20 inch.

PERNA JANUS, Carpenter; variety.

Two examples. La Paz (No. 73561, U. S. N. M.), Forrer.

This is an interesting intermediate form, which unites in the individual before me the characters of Dr. Carpenter's *Janus* and Orbigny's *Chemnitzianum.* The greater portion of the exterior, exhibits the coarse, laminated growth of the latter generally exhibited in the species, and is posteriorly produced and elongated as is common in said form. The later growth, however, shows on the edge of the posterior side near the dorsal line, as well as on the anterior side, towards and extending to the ventral margin, the radiating striæ, which Carpenter refers to as a characteristic of *P. Janus.* The specimen is foot or hatchet-shaped, and measures 1.12 inches in length, 1.61 inches in breadth.

PERNA CHEMNITZIANA, Orbigny.

Several specimens.

Pichilinque Bay (one good example); Station 2828, off Lower California, in 10 fathoms (No. 102098, U. S. N. M.); *Albatross.*

Family MYTILIDÆ.

MYTILUS MULTIFORMIS, Carpenter.

Several specimens. Tres Marias (No. 41623, U. S. N. M.).

SEPTIFER CUMINGIANUS, Dunker.

Station 2827, 10 fathoms shelly bottom off Lower California, *Alba-*

tross (No. 102104, U. S. N. M.). The specimen was attached to a *Placunanomia* valve.

MODIOLA CAPAX, Conrad.

One example.

La Paz, Forrer. Sta. Margarita Island (fragment), *Albatross.*

The late J. A. McNeil, so well known for the archæological material collected by him in Chiriqui, etc., obtained the above species in the Bay of Fonseca.

MODIOLA BRAZILIENSIS, Chemnitz.

Two examples.

La Paz, Forrer (No. 63706, U. S. N. M.); Hemphill has carried the distribution much farther to the north, having collected it in San Ignacio Lagoon (No. 105601, U. S. N. M.). Dr. Edward Palmer found it quite abundant near Guaymas, and the late J. A. McNeil obtained beautiful clean examples at the more southerly locality of the Bay of Fonseca (No. 63705, U. S. N. M.). It is a well marked species.

LITHOPHAGUS? ARISTATUS, Solander.

Two examples.

Burrowing in *Spondylus princeps*, Station 2828, 10 fathoms off Lower California, also fragments Sta. Margarita Island; *Albatross.*

Family ARCIDÆ.

ARCA PACIFICA, Sowerby.

One specimen. San Juanico.

ARCA (SCAPHARCA) LABIATA, Sowerby.

Several specimens. Animas Bay (No. 41604, U. S. N. M.).

This pretty species is represented in the Fisher collection by numerous examples, all fresh and perfect; its geographical range extends from Peru to the above locality, the most northerly thus far reported. Gabb collected it at Loreto (No. 74836, U. S. N. M.), and Bridges detected it at San Juan del Sur, in Nicaragua (No. 74837, U. S. N. M.).

ARCA (SCAPHARCA) TUBERCULOSA, Sowerby.

Two specimens. Magdalena Bay (No. 74813, U. S. N. M.); San Juanico, Gabb; Guaymas, E. Palmer (No. 23617, U. S. N. M.).

ARCA (SCAPHARCA) MULTICOSTATA, Sowerby.

Numerous examples.

Scammon's Lagoon on mud flats (No. 105596, U. S. N. M.), Hemphill;

San Quentin Bay, Belding; San Juanico, Gabb; Guaymas (No. 23616, U. S. N. M.), Dr. Palmer.

ARCA (NOETIA) GRANDIS, Broderip and Sowerby.

A few examples. Guaymas (No. 23616, U. S. N. M.), Dr. Palmer; San Juanico.

ARCA (BYSSOARCA) GRADATA, Broderip and Sowerby.

Abundant. Point Escondido; St. Josef Island; La Paz. Ranges southerly to Ecuador.

ARCA (BYSSOARCA) SOLIDA, Sowerby.

Common. Point Escondido (No. 75012, U. S. N. M.); St. Josef Island; La Paz; found nearly everywhere in the Gulf, and in South America on the coast of Peru. The *Albatross* collection contained one valve from Sta. Margarita Island.

ARCA (BYSSOARCA) REEVIANA, Orbigny.

Several specimens. Mulege Bay (No. 74825, U. S. N. M.); La Paz (No. 34100, U. S. N. M.), Belding; San Ignacio Lagoon (No. 105612, U. S. N. M.), H. Hemphill, "underside of stones."

ARCA (BYSSOARCA) MUTABILIS, Sowerby.

One living example. Tres Marias (No. 102184, U. S. N. M.).

PECTUNCULUS (AXINÆA) MACULATA, Broderip.

Three examples. La Paz (No. 63782, U. S. N. M.), S. Pillsbury.

PECTUNCULUS (AXINÆA) TENUISCULPTUS, Carpenter.

Several specimens. Carmen Island (No. 63776, U. S. N. M.), Towne.

PECTUNCULUS (AXINÆA) GIGANTEUS, Reeve.

Numerous examples. La Paz and San Josef Island; Guaymas (No. 23547, U. S. N. M.), Palmer; Carmen Island (No. 63777, U. S. N. M.), Towne. An adolescent example at the first named locality was collected by Capt. Forrer (No. 63781, U. S. N. M.), and Fisher's, from St. Josef Island, were all young shells. Towne's Carmen Island specimens were very fine.

Family LEDIDÆ.

LEDA (YOLDIA) LANCEOLATA, Lamarck.

Numerous valves. Gulf of California (No. 73667, U. S. N. M.).

This form is exceedingly rare; odd values are occasionally met with in beach rubbish.

Family CARDITIDÆ.

CARDITA PECTUNCULUS, Bruguiere.

+ *C. affinis*, SOWERBY.
+ *C. Californica*, DESHAYES.

Two specimens.

La Paz (No. 73610, U. S. N. M.); Loreto (No. 73611, U. S. N. M.), Dr. Gabb. Sta. Margarita Island (two good examples), *Albatross*.

CARDITA (VENERICARDIA) FLAMMEA, Michelin, 1830.

+ *C. varia*, BRODERIP, 1832.
+ *C. tumida* of the same author.

Several specimens. Tres Marias (No. 73619, U. S. N. M.); Mulege Bay (No. 73618, U. S. N. M.).

Magnificent examples of this fine species have been dredged by the U. S. Fish Commission steamer *Albatross*. These are of a pinkish color with whitish and darker markings, and measure 69 millimeters from beak to ventral margin (about $2\frac{3}{4}$ inches).

CARDITA (VENERICARDIA) CRASSA, Gray.

One specimen. Tres Marias (No. 73625, U. S. N. M.).

The single example of this well-marked form obtained is about two-thirds the size of the figure in Reeve's monograph, species 34.

Family CRASSATELLIDÆ.

CRASSATELLA GIBBOSA, Sowerby.

One adolescent specimen.

San Lucas Cove (No. 75033, U. S. N. M.). The example, though small, is quite characteristic; it was obtained by dredging. This species is exceedingly rare. Dr. Jones collected four odd valves at Payta, Peru, in 1884, and Gabb detected it at Loreto in 1867 (No. 73522, U. S. N. M.); Guaymas, Dr. Palmer (No. 23548, U. S. N. M.).

Family LUCINIDÆ.

LUCINA (DIVARICELLA) DENTATA, Wood.

Examples. San Juanico and Loreto; Dr. Gabb.

An interesting form occurring in the Atlantic Dall gives the range from Georges Bank off Hatteras, to the West Indies, thence southerly to Brazil, in from six to fifty-two fathoms. The above is the *Cyclas dentata* of the older authors.

LUCINA BELLA, Conrad,

Fresh specimen. Gulf of California.

A single example in perfect condition. Precise locality not stated. Not uncommon among Gulf material.

LUCINA CALIFORNICA, Conrad.

One specimen. La Paz (No. 41626, U. S. N. M.), A. Forrer.

LUCINA NUTTALLI, Conrad.

Numerous examples.

La Paz (No. 101750, U. S. N. M.); also at various places on the ocean side of Lower California to California proper, San Diego, San Pedro, etc.

LUCINA (CODAKIA) TIGRINA, Linnæus.

Several examples.

Pichilinque Bay (3 fresh valves); *Albatross*. Carmen Island (No. 73497, U. S. N. M.), Towne; Gulf of California (No. 73496, U. S. N. M.); La Paz (No. 34094, U. S. N. M.), L. Belding. This is another widely distributed species, credited to various remotely separated regions. Garrett * gives the Viti and Samoan islands as localities in the Indo-Pacific province. Dall † gives the Atlantic range as St. Augustine, Fla., Florida Keys, West Florida, Texas, Bermuda, to Aspinwall, and it occurs fossil as far back as the Pliocene.

Family DIPLODONTIDÆ.

DIPLODONTA ORBELLA, Gould.

Two examples.

Point San Quentin (No. 73632, U. S. N. M.); also, San Juanico, collected by Dr. Gabb; Gulf of California (No. 41603, U. S. N. M.).

DIPLODONTA (FELANIA) SERRICATA, Reeve.

Several examples.

Mazatlan (No. 73635, U. S. N. M); San Ignacio Lagoon (No. 105621, U. S. N. M.), Hemphill; Gulf of California, at head of the Gulf, Dr. Palmer (No. 58335, U. S. N. M.).

Family GALEOMMIDÆ.

SCINTILLA CUMINGII, Deshayes.

Two examples.

Gulf of California (No. 73628, U. S. N. M.); Cape St. Lucas (No. 41613, U. S. N. M). A very rare form. From Todos Santos Bay (No. 102187, U. S. N. M), the Museum contains what may prove to be another species of this genus.

Family LASEIDÆ.

LASEA RUBRA, Mont.; var. SUBVIRIDIS, Carpenter.

Several examples.

Cape St. Lucas (No. 74018, U. S. N. M.); San Quentin Bay (No. 75032,

* Catalogue IV, Museum Godeffroy, May, 1869.

† Marine Mollusks S. E. coast of the United States, 1889.

U. S. N. M.), "found among *Mytilus* on rocks [Fisher], April 27, 1876;" also at Monterey, Cal., two specimens. The foregoing was Dr. Carpenter's determination, copied from his label.

Family CHAMIDÆ.

CHAMA PANAMENSIS, Reeve.

One example; La Paz, Capt. Forrer.

CHAMA? FRONDOSA, Broderip.

Three specimens.

Gulf of California (No. 74805, U. S. N. M.), attached to valve of *Meleagrina fimbriata.* Altogether a fine series.

At Station 2828, off Lower California, in 10 fathoms (probably this species), *Albatross.*

Family CARDIIDÆ.

CARDIUM SENTICOSUM, Sowerby.

Several examples.

San Juanico; also found in the Gulf of California at the head of the Gulf (No. 36085, U. S. N. M.); Dr. E. Palmer (No. 63752, U. S. N. M.). Very close to the more northern "*quadrigenarium*" of Conrad, and may prove to be the same.

CARDIUM PROCERUM, Sowerby.

One specimen.

Magdalena Bay (No. 63740, U. S. N. M); Guaymas (No. 23499, U. S. N. M.), Dr. Palmer. Ballenas Bay (valves), and on good example at Pichilinque Bay, *Albatross.*

CARDIUM MACULOSUM, Wood.

One valve.

Gulf of California (No. 63744, U. S. N. M.), Stearns collection; an exceedingly rare and characteristic species.

CARDIUM CONSORS, Broderip and Sowerby.

Several examples; common.

La Paz (Nos. 34091, 63748, U. S. N. M.); Mazatlan (No. 63747, U. S. N. M.); Acapulco (No. 13783, U. S. N. M.); Carmen Island (No. 63746, U. S. N. M.), Towne. This last is rather varietal than typical, being not quite characteristic. The *Albatross* dredged two dead valves at Station 2828, 10 fathoms off Lower California.

CARDIUM (PAPYRIDEA) ASPERSUM, Sowerby.

One example.

La Paz, Forrer (No. 63769, U. S. N. M.). The National collection has the same species from Carmen Island (No. 63768, U. S. N. M.); La Paz

(valve), L. Belding (No. 34092, U. S. N. M.); Gulf of California several (No. 63767, U. S. N. M.); San Juanico, Gabb.

A rare species and closely approaching the Antillean *P. bullatum*. Cuming collected it at St. Elena, on the coast of Guayaquil, in latitude about 2° south.

CARDIUM (LIOCARDIUM) APICINUM, Carpenter.

= ? *Elenense*, Carpenter's Maz. Cat.

Numerous examples.

Boca de los Piedras (No. 63759, U. S. N. M.), fine examples. A variety of this species was obtained at Mulege Bay (No. 63760, U. S. N. M.), two specimens; Mazatlan (No. 63758, U. S. N. M.); Cape St. Lucas (No. 63761, U. S. N. M.), Xantus.

CARDIUM (LIOCARDIUM) ELATUM, Sowerby.

Numerous examples.

Guaymas; Pinecate Bay (No. 23515, U. S. N. M.), Dr. E. Palmer; Gulf of California (Nos. 63737, 34093, U. S. N. M.); San Ignacio Lagoon (No. 105398, U. S. N. M.), and San Diego (No. 63738, U. S. N. M.), Henry Hemphill. A magnificent species. Our largest example, a single valve measures $6\frac{5}{8}$ by $5\frac{5}{?}$ inches. Santa Margarita Island (one valve), *Albatross*.

Family VENERIDÆ.

VENUS MULTICOSTATA, Sowerby.

Several examples.

Escondido Bay (No. 63667, U. S. N. M.), Fisher; La Paz, Forrer.

The largest of Mr. Fisher's specimens measured, length 4.75, height 3.87, breadth 2.63 inches. The young of the above might easily be mistaken for adolescent shells of *V. reticulata* or *V. puerpera*, Indo-Pacific species. Notwithstanding the very great quantity of West coast materialt hat has passed under my examination, Mr. Fisher's were the first specimens that I had seen from the Gulf region.

VENUS CRENIFERA, Sowerby.

Several examples. Carmen Island (No. 63598, U. S. N. M.), Towne; Cape St. Lucas (No. 23594, U. S. N. M.), Dr. Palmer; also same locality (No. 13732, U. S. N. M.). A rare and beautiful species.

VENUS (ANOMALOCARDIA) SUBRUGOSA, Sowerby.

= No. 112. Carpenter's Maz. Cat.

Abundant.

Mulege Bay; Gulf of California; Guaymas (No. 23589, U. S. N. M.), Dr. Palmer; a single specimen, the smallest I have seen, only .36 inch long by .29 inch in height, having every aspect of maturity; it would lead a person, without a large series of all ages for comparison, to regard

it as a different species. Adults measure from .97 inch to 1.53 inches long, by .80 inch to 1.25 inches high, respectively. Though a strongly characterized species, several individuals are requisite to properly represent it. The National collection contains a beautiful variety of the above (No. 63567, U. S. N. M.) from Nicaragua, in which the rounded concentric ridges are quite regular, and extend over the entire surface of the valves to the ventral edge.

VENUS (ANOMALOCARDIA) SUBIMBRICATA, Sowerby.

One perfect example, several valves. Santa Margarita Island, *Albatross.*

VENUS (ANOMALOCARDIA) KELLETTII, Hinds.

Numerous examples.

Mulege Bay (No. 41617, U. S. N. M.), one junior, less than half an inch (transverse) length; Guaymas (No. 23567, U. S. N. M.), Dr. Edward Palmer; also numerous valves from the latter place (No. 103280, U. S. N. M.).

VENUS (CHIONE) UNDATELLA, Sowerby.

A single example. Tres Marias (No. 63605, U. S. N. M.).

A single specimen of this beautiful species, distinguished by its fine, closely approximating concentric costæ crossing rather broad, flat or slightly rounded radiating ribs, more or less marked with light brown, in zigzag waves, and spotted or blotched on the surface of the valves. Lunule rounded cordate and dark brown. Ligamental area deeply excavated and marked with brown bars on the left valve. Hinge line very heavy. Muscular and pallial scars strongly impressed. Color inside, light orange and purple.

The various forms of this genus are so profusely abundant on the West coast, and exhibit so much variation through the influence of station, character of the sea bed, etc., that no doubt too many species have been made. The West American group requires careful revision.

VENUS (CHIONE) FLUCTIFRAGA, Sowerby.

Two examples.

San Juanico (No. 74264, U. S. N. M.); Scammon's lagoon; Colorado River, Fort Yuma (No. 36409, U. S. N. M.); Guaymas (No. 23595, U. S. N. M.), Dr. Palmer. Extends northerly along the coast to San Diego and San Pedro.

VENUS (CHIONE) SUCCINCTA, Valenciennes.

Not uncommon. San Juanico; Loreto (doubtful). Guaymas (No. 23592, U. S. N. M.), Palmer; La Paz (No. 34084, U. S. N. M.), L. Belding.

VENUS (CHIONE) SIMILLIMA, Sowerby.

Several specimens.

San Quentin Bay (No. 34503, U. S. N. M.), Belding; San Juanico; Todos Santos Bay (No. 74268, U. S. N. M.), Hemphill. *C. succincta* and

C. simillima, are common species as far north as San Diego and San Pedro. Pichilinque Island, numerous examples, living; *Albatross*.

VENUS (CHIONE) NEGLECTA, Carpenter.

Not uncommon.

Boca de los Piedras (No. 73917, U. S. N. M.); Magdalena Bay (No. 63604, U. S. N. M.); Cape St. Lucas (No. 23558, U. S. N. M.), Dr. Palmer (?) Cerros Island (No. 13656, U. S. N. M.).

Eight, all juniors at the first place, numerous examples at the others.

VENUS (CHIONE) COLUMBIENSIS, Sowerby.

Several examples.

Mazatlan (No. 63594, U. S. N. M.), H. Edwards (No. 2431, U. S. N. M.). Rich collection. Upon a revision of this group, the position of the above species may have to be changed.

VENUS (CHIONE) GNIDIA, Broderip and Sowerby.

Numerous examples.

Guaymas (No. 23498, U. S. N. M.), Palmer; Mulege Bay (No. 2501, U. S. N. M.); La Paz (No. 34083, U. S. N. M.), Belding; San Ignacio Lagoon (No. 105597, U. S. N. M.), Hemphill. A fine species and comparatively abundant.

CYTHEREA (CALLISTA) CHIONÆA, Menke.

Two adolescent examples.

La Paz (No. 63524, U. S. N. M.); Scammon's Lagoon; San Juanico; Loreto; Pichilinque Bay (common), and Sta. Margarita Island (valves); Station 2828, two fresh specimens in 10 fathoms, *Albatross*.

This common species is found at a great many places in the Gulf and on the outer shore of the peninsula of Lower California. Gabb collected it at San Juanico, also at Loreto on the Gulf side (No. 63525, U. S. N. M.). It is frequently found in large numbers on Carmen Island, cast up on the beach after a storm. A rare and beautiful variety, resembles in its color markings the Asiatic *Cytherea petichialis*, which has led to said species being credited to the west coast of America.

CYTHEREA (CALLISTA) AURANTIA, Hanley.

Three valves in good condition. Pichilinque Bay, *Albatross*.

CYTHEREA (CALLISTA) POLLICARIS, Carpenter.

One specimen. Mulege Bay (No. 63538, U. S. N. M.).

The example collected at the above place by Mr. Fisher I refer to Carpenter's species, on the basis of form and sculpture. Carpenter's type was collected by Xantus at Cape St. Lucas (No. 12721, U. S. N. M.); it is a large, white, smooth-surfaced shell, measuring laterally 63 mm. by 57 mm. from umbos to the ventral margin of the valves; while

Fisher's shell is correspondingly but 20 and 15 mm. Fisher's shell is painted with light yellowish-brown markings, while the Xantus-Carpenter shell has but a few slight indications of color. Another example agreeing closely with the Mulege shell is in the National collection, also a junior. A very rare species.

CYTHEREA (CALLISTA) VULNERATA, Broderip.

Two good specimens.

Station 2828, 10 fathoms, off Lower California; *Albatross*.

This is a beautiful species, but not uncommon at many places around the shores of the Gulf and peninsula.

CYTHEREA (CALLISTA) NEWCOMBIANA, Gabb.

One specimen.

Boca de los Piedras (No. 41628, U. S. N. M.). Ranges to Catalina Island and northward on the coast of California.

CYTHEREA (TIVELA) RADIATA, Sowerby.

One example. San Juanico. Common in the Gulf.

CYTHEREA (TIVELA) CRASSATELLOIDES, Conrad.

One junior only 22 mm. long. Ballenas Bay, *Albatross*. Abundant farther north.

DOSINIA PONDEROSA, Gray.

Three specimens.

Gulf of California (No. 63511, U. S. N. M.); San Juanico. The above is fully as common in the Gulf region and at various places on the ocean side of the peninsula as *D. Dunkeri*, Philippi is in the neighborhood of Panama. Carpenter's species *D. Annæ* seems to be of rather rare occurrence. *D. ponderosa* is also reported from Scammon's Lagoon.

DOSINIA PROSTRATA, Linnæus.

One valve (the left); beach. Gulf of California (No. 74235, U. S. N. M.).

Among the miscellaneous material in the Fisher collection was a single valve, the left, of a species of *Dosinia* unlike either of the species heretofore credited to this province or region. I sent it to the late Mr. Tryon for comparison with the various forms of *Dosinia* in the collection of the Philadelphia Academy; he returned it with the comment that it "exactly corresponds with *D. prostrata* from Coromandel (Chemnitz)."

The shell certainly differs from *Annæ*, *Dunkeri* and *ponderosa*. I should regard the occurrence of the above at any point in the Gulf

region as in some way fortuitous were it not for the other forms herein mentioned, such as *Cassis vibex*, *Murex palma-rosæ Mexicana*, *Purpura hippocastaneum*, etc., some of which have been verified as to locality by other collectors, etc.

Subfamily Tapesinæ.

TAPES GRATA, Say.

Numerous specimens.

Los Animas Bay (No. 63587, U. S. N. M.); Loreto (No. 63586, U. S. N. M.). This well known and pretty species is quite widely distributed on the West coast; the National collection contains examples from a great number of localities collected by Hemphill, Bridges, and others. Several fresh valves were obtained at Sta. Margarita Island by the *Albatross*.

Family Donacidæ.

DONAX CARINATA, Hanley.

Three specimens. Altata, A. J. Gove (No. 63671, U. S. N. M.). A rare and beautiful form.

74. DONAX TRANSVERSUS, Sowerby.

One specimen. Altata, Gove (No. 63672, U. S. N. M.). This is another rare species.

DONAX PUNCTATOSTRIATUS, Hanley.

Three examples. Altata (No. 63673, U. S. N. M.).

DONAX FLEXUOSUS, Gould.

One specimen. San Juanico.

HETERODONAX BIMACULATUS, Orbigny.

= *Tellina vicina*, C. B. Adams.

Numerous large, fine specimens.

Angeles Bay (No. 73535, U. S. N. M.), and all around the Gulf of California, nearly everywhere up to northern California; southerly to Panama; also in the Antillean waters. The Gulf shells exhibit in many instances very beautiful coloration.

Family Psammobiidæ.

PSAMMOBIA REGULARIS, Carpenter.

Valves, beach. Tres Marias (No. 73516, U. S. N. M).

This form, described by the late Philip Carpenter in the Ann. and Mag. of Natural History (third series) Vol. XIII, 1864, is quite rare in collections and only occasionally met with in fragments or odd valves

in beach rubbish from the Gulf of California. It is barely possible that it is only an extra limital, dwarfed, delicate aspect or southern form, of *P. rubroradiata* of Conrad of the Northern Californian and Vancouver province, where *rubroradiata* attains a large size.

Two examples of *regularis* give the following dimensions from anterior to posterior margins: largest, 1.44, smallest, 1.21 inches.

TAGELUS CALIFORNIANUS, Conrad.

=*Solecurtus Californianus*, CONRAD.
=*S. affinis*, C. B. ADAMS.

Four examples. San Lucas Cove (No. 73474, U. S. N. M.); San Juanico.

The individuals examined, are small compared with the average of examples from Northern California localities; the largest measuring only 2.10 inches from anterior to posterior extremities, but unquestionably of this species.

SOLETELLINA RUFESCENS, Chemnitz.

Three specimens. Altata (No. 73547, U. S. N. M.), Gove.

SANGUINOLARIA KINDERMANNI, Philippi.

Several Examples. San Juanico.

Family TELLINIDÆ.

TELLINA, doubtful species.

One example. La Paz, Capt. Forrer (No. 102182, U. S. N. M.).

TELLINA (TELLINIDES) PURPUREUS, Broderip.

=*T. Broderipii*, DESHAYES.

Valves beach. Altata, Gove (No. 73545, U. S. N. M.); Acapulco, Jewett (No. 15994, U. S. N. M). A rare species.

MACOMA VIRIDITINCTA, Carpenter.

One specimen. La Paz, Capt. Forrer; Gulf of California, various localities; rather rare.

Family SEMELIDÆ.

SEMELE BICOLOR, C. B. Adams.

One example. Loreto, Gabb.

SEMELE CORRUGATA, Broderip.

Valves and fragments. Sta. Margarita Island; *Albatross*.

Family Mactridæ.

MACTRA (STANDELLA) PLANULATA, Conrad.

Specimens. San Juanico. Station 2828, 10 fathoms off Lower California; *Albatross*.

LABIOSA UNDULATA, Gould.

= *Raeta undulata*, GRAY.

Valves only; rare. Loreto, Gabb. Occurs elsewhere in the Gulf and up the coast northward to San Pedro.

Family Anatinidæ.

THRACIA PLICATA, Deshayes.

= *T. truncata*, MIGHELS.

Very rare; valves only. La Paz (No. 73602, U. S. N. M.).

PERIPLOMA PLANIUSCULA, Sowerby.

+ *P. lenticularis*, SOWERBY.
= *P. argentaria*, CONRAD.
= *P. alta*, C. B. ADAMS.
= *P. excurva* + *excurvata*, CARPENTER.

Numerous examples.

San Juanico (No. 73518, U. S. N. M.); Loreto (No. 73517, U. S. N. M.), Gabb. Common at many places on the ocean coast of the peninsula; northward to San Pedro; common in the "fossil bank" at Spanish Bight, Coronado peninsula, San Diego; perhaps northerly to Point Concepcion.

Family Corbulidæ.

CORBULA BICARINATA, Sowerby.

Numerous specimens.

Gulf of California (No. 73500, U. S. N. M.); Boca de los Piedras (No. 73641, U. S. N. M.); Mulege Bay (No. 73645, U. S. N. M.).

Class SCAPHOPODA.

Family Dentaliidæ.

DENTALIUM FISHERI, provisional name.

One example. Los Animas Bay (No. 46204, U. S. N. M.).

DENTALIUM SEMIPOLITUM, Carpenter.

Numerous specimens.

Mulege Bay (Nos. 46201, 46202, U. S. N. M.); Boca de los Piedras (No. 46203, U. S. N. M.). Hemphill has collected this species at San Ignacio Lagoon, Lower California (No. 105517, U. S. N. M.).

Class GASTROPODA.

Family BULLIDÆ.

BULLA ADAMSI, Menke.

Several specimens.

Bocas de los Piedras and Loreto, Gulf of California.

Less globose and inclined to be heavier and more solid than *B. nebulosa* Gould. The latter averages much larger than *B. adamsi.*

Family APLYSIIDÆ.

DOLABELLA CALIFORNICA, Stearns.

Dolabella californica, STEARNS, Proc. Phila. Acad. Nat. Sci., 1878, p. 395, Pl. VII, figs. 1, 2; Proc. U. S. Nat. Museum, Vol. XVI, pp. 341-342, 1892.

Several examples (No. 75001, U. S. N. M.). Mulege Bay, Gulf of California.

Superfamily MONOTREMATA.

Family HELICIDÆ.

HELIX (ARIONTA) AREOLATA, Forbes.

=*Euparypha** *areolata,* BINNEY.

Abundant (No. 58470, U. S. N. M.). Santa Maria Island, Lower California.

* Whatever may be the subgeneric or sectional value of *Euparypha,* I do not believe that any of the West American species can properly be assigned to it. Environmental influences have brought about certain external facies analogous to those exhibited by some of the terrestrial species that inhabit the Mediterranean region, the Canaries and Madeira, where, to a certain extent, similar environmental factors exist.

I regard all of the west coast forms to which the names of *Tryoni, areolata, Veatchii, pandora, lævis,* etc., have been given as physiographical aspects or modifications of *Arionta,* as this genus is represented on the west coast by the more northerly and characteristic forms of central California, generally placed by systematists in H. and A. Adams's section *Lysinæ.*

Proceeding southerly from the regions of maximum or moderate rainfall or humidity the extremes of external characters, exhibited by the Helices of southern California and the peninsula, in color, solidity, elevation, etc., and general facies, when compared with their congeners of the central region, seem to me, when a large geographical series is examined, to be gradually approached. We should

Mr. Fisher found this species common on the shores of Santa Maria Bay, which is a small bay indenting an island of the same name outside of Magdalena Bay. The ample quantity he collected includes numerous solid shells of a pure opaque white with a somewhat glazed surface; others spotted here and there with sienna yellow and brown. Many examples are striped and ornamented with more or less conspicuous bands broken into squarish spots of the same color. Columella generally showing a single blunt tubercle, sometimes not.

From the U. S. Fish Commission, collected by the *Albatross* naturalists, a magnificent series has been received from Margarita Island (No. 10248, U. S. N. M). These are of exceeding interest as related to the examples collected by Mr. Fisher, as the two lots illustrate how very considerable is the variation in color, size, and elevation within a comparatively limited area. The *Albatross* shells are, as a whole, much the largest that I have seen of this species.

HELIX (ARIONTA) AREOLATA, Forbes.

Var. = *Veatchii*, NEWCOMB.

Numerous examples.

Helix Veatchii (No. 58504, U. S. N. M.), a form generally regarded as a variety of *H. areolata*, occurs on Cerros Island. It was a specimen of this that furnished an interesting illustration of the extraordinary vitality of these insignificant animals. Dr. Veatch collected numerous specimens on the island in 1859, and gave some of them to Thomas Bridges. These ultimately passed into my hands. One day, upon examining them, I noticed that one was alive. I placed it in a box of moist earth, and in a short time it commenced crawling about, apparently as well as ever. After a fortnight's furlough from its long imprisonment in a small box, I put it back again. *It had lived six years* without food.* The famous British Museum example of *Helix desertorum* lived nearly *four years*. This last species is from a region in which the physical characteristics are in many respects like those of Cerros Island and Lower California.

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expect to find a wide range of modification within a territory so peculiar, practically a long and narrow belt extending through some 1,000 or 1,200 miles of latitude, from a region of ample, not to say excessive, moisture or humidity to one of extreme aridity, to say nothing of other diverse characteristics which play their part in influencing or inducing variation.

Whatever may be the value of the characters of the soft parts in the land snails as a basis for grouping or generic segregation, Binney has found in *Tryoni*, which he has placed in *Euparypha*, certain characters in common with *Arionta* (*Stearnsiana*), in others it is different. Whether this difference is of greater than specific weight or anything more than varietal, remains to be investigated, for it is yet to be proved whether the soft parts are out and out, less variable or more constant in their characters than the hard parts, that is to say, the external inclosing shell.

* Proc. California Acad. Nat. Sciences, March 4, 1867.

Besides the specimens of the above, received in the Stearns collection the National Museum contains three of the original lot collected by Dr. Veatch on Cerros Island (Nos. 8715, 8716, U. S. N. M.), two collected by Lieut. Pond (No. 103610, U. S. N. M.), five received from Mr. Belding, collected by him near San Quentin Bay (No. 34525, U. S. N. M.), one example from an island in said bay (No. 73433, U. S. N. M.), numerous examples from Cerros Island (U. S. Fish Commission, No. 102421, U. S. N. M.), and two examples collected by Henry W. Henshaw on Cerros Island (No. 63986, U. S. N. M.).

HELIX (ARIONTA) LÆVIS, Pfeiffer.

= *Euparypha lævis,* BINNEY.
+ *Polymita lævis,* TRYON.

Abundant; dead. Ascunsion Island, Lower California (No. 58527, U. S. N. M.).

This island is of small area; it is situated south of Cedros, or Cerros, in latitude 27°. The above, as well as *H. pandora* Fbs., are probably dwarfed varieties of *areolata.* A large number, all dead, were obtained by Mr. Fisher. They exhibit a rather wide range of variation, particularly in elevation, and the tubercle on the columella is shown to be an inconstant character; the color markings are variable, as in *areolata.* From Fisher's notes I learn that he found the foregoing "on plateaus from 50 to 300 feet above the sea level, in great numbers, embedded in sand mixed with guano. Found only *four plants,* small shrubs (individuals), on the island, otherwise utterly destitute of vegetation." In conversation Mr. Fisher informed me that the specimens he obtained had been scratched out of the sand and guano by the sea-fowls in excavating or making a hollow for nesting purposes. It is quite evident that the faunal and floral character of the island has undergone a great change within quite recent times. Not many years ago when these snails were living, and before the sea-birds took possession of it, the surface of the island, which quite likely was never very densely clothed with vegetation, exhibited, we may presume, about the same floral aspect as others in the same general region. The birds, disturbed elsewhere, or from some other cause, invaded the territory of *H. lævis,* and in destroying the vegetation also extinguished the snails and such other forms of animal life as were dependent upon it for food. Fisher told me that he failed absolutely to detect a single *living* individual of *H. lævis.* Here we have an instance where the extension of the specific area of one form or class of animal life, obliterated or diminished the territory or specific area of another. It would be interesting to know of similar instances, for doubtless such have been observed and noted. Mr. Orcutt collected numerous examples of this species, living and in fine condition, near El Rosario Mission, in latitude 29° 50′. He found them "abundant under *Agave Shawi,* on high

mesa lands." The Museum is indebted to him for an excellent series (Nos. 98930, 98931, U. S. N. M.), which includes also a dark-colored variety (No. 98932, U. S. N. M.).

HELIX (POLYGYRA) BEHRI, Gabb.

Several examples. Near Guaymas (No. 58514, U.S.N.M.); banks of Yaqui River (No. 23766, U. S. N. M.), Gabb.

A few specimens (seven or eight), all dead and bleached, though otherwise perfect, were detected as above by Mr. Fisher. The species was described by the late Prof. Gabb, in volume 1 of the American Journal of Conchology, 1865, p. 208, from specimens collected by the lamented Auguste Rémond, near Guaymas, on the easterly side of the Gulf of California. The specimens collected by Rémond were also dead, as implied by Gabb's description, wherein he says "colore albo (?)". When living they are probably of a pale horn color, like others of this group found in the same general region. The Fisher shells, though having the same number of whorls and agreeing with Gabb's description, vary in diameter from 0.49 to 0.67 of an inch. To verify my determination, specimens were submitted to my esteemed friend, the late Thomas Bland, of New York, whose kind services in connection with the above and other critical West American forms, are gratefully remembered and acknowledged.

HELIX (POLYGYRA) BICRURIS, Pfeiffer.

Ten examples.

Gulf of California region (No. 56957, U. S. N. M.); Monterey, Mexico (No. 121028, U. S. N. M.); Texas, at Brownsville; also at mouth of the Rio Grande (Nos. 123168, 123594, U. S. N. M.), William Lloyd.

HELIX (POLYGYRA) HINDSII, Pfeiffer.

One specimen. Near Guaymas (No. 97974, U. S. N. M.).

HELIX (POLYGYRA) ACUTEDENTATA, W. G. Binney.

Three examples. Mazatlan (Nos. 56942, 56943, U. S. N. M), Henry Edwards.

HELIX (POLYGYRA) VENTROSULA, Pfeiffer.

Several specimens. Mazatlan (Nos. 56944, 60614, U. S. N. M.), Henry Edwards.

HELIX (POLYGYRA) PLATYGLOSSA, Pfeiffer.

Five examples.

Mazatlan (No. 56958, U. S. N. M.); City of Mexico (No. 56931, U. S. N. M.) Puebla, Puebla (No. 56930, U. S. N. M.). The latter were presented

to the Museum several years ago by the Mexican Geographical Commission.

HELIX (STENOTREMA) HIRSUTUM, Say.

Examples. Banks of Yaqui River near Guaymas (No. 37282, U. S. N. M.).*

Of this form Mr. W. G. Binney remarks, in his "Manual of American Land Shells," page 279, a "postpliocene species now found over the northern and interior regions as far as Kansas and Virginia, and even into Alabama." Mr. Pilsbry, in his recent Check List of N. A. Land Shells, credits it to the "Eastern United States."

Upon examining some shells collected on the west coast several years ago by Dr. Edward Palmer, I found that he had obtained this form on the banks of the Yaqui River. It is noteworthy how frequently of late years species heretofore regarded as exclusively eastern or northeastern turn up somewhere on the West coast. A few years ago Dr. Cooper sent specimens of what proved to be, on Dr. Dall's identification, *Hyalina Binneyana* Morse, from Vancover Island, B. C., previously credited to the "Southern part of Maine, Michigan, Massachusetts, Vermont," and Mr. Hemphill found *Helicodiscus lineatus*, another of Say's species, several years ago in Oakland, on the eastern side of San Francisco bay. This had previously been reported as far to the west as the Rio Chama, New Mexico.

Dr. Cooper, in his recent paper before referred to, describes a varietal form of the last named species, to which he has given the name of *Helocodiscus lineatus Sonorensis* detected near San Miguel, in the State of Sonora.

Family ORTHALICIDÆ.

ORTHALICUS UNDATUS, Bruguiere.

One specimen. Tres Marias (No. 56975, U. S. N. M.).

The above example was collected living; the color pattern is of the usual irregularly undulating zigzag wave, and clouds, with rather a darker hue than the average of Florida specimens, and the aperture, or around the aperture, exhibits more or less of the darker tint that prevails over the general surface of the shell. The museum contains several examples of this species from Altata (No. 56973, U. S. N. M.), and I presume it is found at many points on the mainland in the timbered regions of the Mexican States of Sonora and Cinaloa, from whence it is brought in the dyewoods to the embarcaderos along the gulf shore. The Altata shells are on the whole somewhat lighter in general tone, though exhibiting the usual color pattern. The individuals of this form vary greatly in proportions as well as in color markings; in the former

* Vide "Nautilus," November, 1889.

respect they are like the *Bulimuli* of Texas on the one side and Lower California on the other.

ORTHALICUS UNDATUS, Bruguiere.

var. ?=*O. melanochilus*, VALENCIENNES.

One specimen. Tres Marias (No. 56974, U. S. N. M.).

A living example nearly white, upper whorl pinkish white; without color markings save two narrow dark brown oblique *varical* lines on the penultimate and final whorl. The parietal wall and the edge of the outer lip blackish-brown as usual in the common dark colored specimens from Central America. Length 2.20 inches.

I regard this as simply a variety of the previous form, and both the same with the Central American and Florida shells so far as species are considered. The albinoism of the foregoing specimen is of interest when considered in relation to the environment and general character of the region wherein it is indigenous.

Family BULIMULIDÆ.

BULIMULUS (SCUTALUS) BAILEYI, Dall.

= *B. Xantusi*, var. *Stearns*, not *Binney*. Proc. U. S. Nat. Mus., vol. XVI, 1893, pp. 640–641, pl. LXXI, fig. 1.

Several examples.

Cape St. Lucas (No. 58649, U. S. N. M.); Guaymas, E. Palmer (No. 101756, U. S. N. M.); Ortiz, V. Bailey (No. 106004, U. S. N. M.). Five specimens of what I regarded as a variety of Mr. Binney's species were given to me by Mr. Fisher. The precise locality not stated, or else the label was mislaid. The smallest of the five is larger than Binney's figure in his Land and Fresh Water Shells of North America, part 1, p. 210. The incremental lines are well marked, but the revolving lines, an inconstant and quite uncertain character in West American Land Shells, I have barely detected in some of the specimens, of which all but one are dead. The largest measures 1.05 in length and .55 inch in breadth. They vary in solidity and opacity. This form is not confined to the peninsula. The National collection has received examples from the Department of Agriculture (No. 106004, U. S. N. M.), collected by Mr. Vernon Bailey "among rocks on the top of a hill 200 feet high," at Ortiz in the interior, a few miles back of Guaymas, in the fall of 1889; this fact as to locality is of some importance, as heretofore our knowledge of the distribution of these Mexican forms has been confined almost exclusively to the peninsula.

The discovery of Mr. Binney's type of *B. Xantusi* shows that the shells collected by Mr. Bailey are not referable to said species even in a varietal relation.

Mr. Gustav Eisen, of the California Academy of Sciences, has col-

lected *B. Baileyi* at Cape St. Lucas, thus verifying Fisher's notes as to habitat.

BULIMULUS (SCUTALUS) PALLIDIOR, Sowerby.

Five specimens. Carmen Island (No. 56591, U. S. N. M.), also Santa Margarita Island (No. 101036, U. S. N. M.).

The above examples are of the typical form, and I believe that these are the first of the species that have been reported from the islands or as having been found at a locality not on the peninsula. The last were collected by Mr. Townsend, of the U. S. Fish Commission steamer *Albatross*, and it will be noticed that these islands (Carmen and Margarita, are on opposite sides of the peninsula. The Santa Margarita specimens are of the rather robust variety described by Dr. Gould as *B. vegetus*.

An interesting example from Carmen Island, which is registered as *B. pallidior* Sby. (No. 58652, U. S. N. M), exhibits such characters as make it a connecting link with Gould's *vegetus* and the *proteus* of Broderip so-called, in the tendency to that sculptural texture of the surface which is called shagreened, or covered with fine granulation. This aspect of sculpture is not uncommon in the land shells that inhabit insular stations, or saline, sterile, and alkaline sandy regions. Many species could be named which occasionally furnish individuals which exhibit this peculiar facies. Examples of this species collected by Prof. George Davidson at San Jose del Cabo (No. 58651, U. S. N. M.) in March, 1873, were kept by me undisturbed in a box until June 23, 1875, when they were taken out for examination. I placed them in a glass jar with some chickweed and other tender vegetable food, and a little tepid water so as to make a warm humid atmosphere. This hospitable treatment induced them to wake up and move about after their long fast and sleep of two years, two months, and sixteen days. Subsequently all died but one, which was exhibited at a meeting of the Cal. Acad. of Sciences, October 18, 1875. This latter example, it will be noticed, lived longer than his fellows, viz, two years and nearly seven months. These San Jose del Cabo specimens are now in the National Collection. The above has been referred to as an introduced form, which I regard as altogether improbable. The same aspects of variation that are seen in the shells of the *alternatus*, *Schiedeanus*, and *patriarchus* bulimoids of Texas, Louisiana, etc., are exhibited in a greater or less degree by their relatives of the Gulf of California region, more particularly by the *pallidior* form, which often exhibits great difference in the size of examples from one colony as compared with specimens from another locality. The roughened surface forms of *pallidior* have been named by Dall *var. striatula*.

BULIMULUS (ORTHOTOMIUM) SUFFLATUS, Gould.

+ *B. vesicalis*, GOULD.

Numerous examples.

Point San Quentin (Nos. 9441, 9442, U. S. N. M.) Fisher, and La Paz, Belding (Nos. 34116, 34118, U. S. N. M.), and same locality Capt. Forrer. The National Collection has other examples from "Lower

California" (Nos. 56945, 56946, U. S. N. M.). Some individuals are much more globose than others; the juniors of the latter form suggest "*pilula;*" but this last is probably distinct. To the slenderer form of *sufflatus* Dr. Cooper has given the varietal name of *insularis*, resting on on examples collected by Mr. W. E. Bryant on Espiritu Santo Island. Belding collected the same at La Paz, and a large series from various localities show a regular graduation from one extreme to the other as in many other species of *Bulimulus*.

BULIMULUS (DRYMÆUS) ZIEGLERI, Pfeiffer.

Three examples, living. Altata (No. 57227, U. S. N. M.).

The above bears a very close relationship to *B. serperastrus* Say, and may prove to be a local variety of that species. The specimens were carried to San Francisco in a cargo of dyewood; their actual habitat is no doubt some distance back from the shore, as Altata is simply a landing and loading place for vessels in the Gulf trade. Mr. Lloyd, of the biological division of the U. S. Agricultural Department, collected three examples of *serperastrus* (No. 123595, U. S. N. M.) at Hidalgo, Mexico, in 1889.

BULIMULUS (DRYMÆUS) CALIFORNICUS, Reeve.

= *Bulimus Californicus*, REEVE, Icon. No. 378, Dec. 1848.—PFEIFFER, Mon. Hel. Viv., III, 422.

One example (No. 56955, U. S. N.M.).

This species credited to California by Reeve has always, so far as habitat is considered, been regarded with doubt by west-coast collectors and authors, for two reasons; first, the occurrence of any form of the group resembling Reeve's figure and compatible with his description has never been verified either from California proper or the peninsula of Lower California; second, the California of the older authors seems to have been a sort of geographical waste-basket, more convenient than authentic in matters pertaining to distribution.

That excellent conchologist, Dr. Gould, regarded the above species as identical with Say's *B. serperastris;** it may prove to be the same. Mr. W. G. Binney dissents from Dr. Gould. Having had occasion to examine and determine several unlabeled specimens from the Gulf region (Stearns collection) I detected a single example of *Californicus*. The specimen exhibits less color marking than is shown in Reeve's figure, but otherwise agrees satisfactorily. On the testimony of this solitary example, I am of the same opinion as Mr. Binney.

Superfamily DITREMATA.

Family ONCHIDIIDÆ.

ONCHIDELLA BINNEYI, Stearns.

Proc. U. S. Nat. Museum, Vol. XVI, 1893, pp. 342, 343.

Several examples (No. 58824, U. S. N. M.). San Francisquita Bay, Los Animas Bay, and Angeles Bay, in the Gulf of California.

* Binney Terr. Moll. U. S. Vol. III, p. 275.

Family LIMNÆIDÆ.

PLANORBIS BICARINATUS, Say.

Many examples.

Mouth of Yaqui River (No. 53677, U. S. N. M.), Dr. Edward Palmer; Portland, Oreg. (No. 47600, U. S. N. M.), and Antioch, Cal., Henry Hemphill.

It is interesting to note the wide distribution of this comparatively well-marked form, to which I have heretofore and at greater length called attention.*

Commencing at Cape Elizabeth, Maine; thence westerly through Lake Simcoe, Canada; thence to Manitoba (Miller Christy), and Winnepeg Lakes (*teste* Bell), still westerly to Portland, Oreg.; thence southerly to the Yaqui River locality near Guaymas, Mexico; thence easterly through Kansas, Alabama, and Georgia nearly to the Atlantic seaboard by the way of Virginia, the District of Columbia, Pennsylvania, New York, and Massachusetts, to the starting point as above given in Maine.

The west-coast localities are as yet "few and far between," and the number of examples limited. It will be observed that there is a great stretch of territory between the Yaqui River locality and the Kansas region, as well as between the Oregon locality and Manitoba. It is not unreasonable to predict or anticipate the detection of *P. bicarinatus* sooner or later at localities intermediate and connecting, when these vast and sparsely-settled areas are more thoroughly explored or more generally inhabited.

The occurrence of Helix (*Stenotrema hirsuta*) near Guaymas is elsewhere referred to in this paper.

PLANORBIS CORPULENTUS, Say.

Several examples.

Cape St. Lucas, Prof. George Davidson, March, 1873. This species is widely distributed and inhabits an extensive geographical area on the western side of the continent, from the Columbia River in the north, thence easterly to Lake Winnipeg. Binney says "*P. corpulentus* is catalogued from Guatemala by Mr. Tristram."

Family SIPHONARIIDÆ.

SIPHONARIA LECANIUM, Philippi.

+var. *palmata*, CARPENTER; +*S. æquilirata*, CARPENTER; +?*S. pica*, SOWERBY.

Abundant. Tres Marias (No. 60386, U. S. N. M.).

The typical form in all stages from adolescence to maturity. It is

* West American Scientist, September, 1889.

evidently very abundant at these islands. In the younger or smaller specimens there is a tendency to a serial or alternate arrangement of prominent ribs with finer intermediate ones or riblets, as Carpenter terms them in his reference to this species in the Mazatlan catalogue, page 132, species 139.* The synonymy as above given is not complete; it should include other specific and varietal names; as the literature is not accessible by which I can verify the references and allusions to many species made by Carpenter and other authors whose comments I have read, I prefer to submit the above with my own notes and observations.

The variety *palmata* (No. 60396, U. S. N. M.) is simply a flattened form of *lecanium* occasionally met with. I regard *æquilirata* as a less strongly sculptured and a closely ribbed variety of *lecanium* minus intermediate riblets, or with smooth interspaces where riblets occur in typical *lecanium*.

The number of species and varieties which have been made is owing apparently to the excessive variability in the number of riblets as well as to the varying prominence of the same, also to variation in elevation or depression. Some individuals have 50 or more closely set nearly equal ribs, as do some of my largest specimens which measure 1.03 greatest length with an elevation of .55 inch; examples of these would be regarded as Carpenter's *æquilirata* (No. 60395, U. S. N. M.). Sometimes as many as 60 nearly equal ribs are exhibited in specimens only .69 inch in length, and .29 inch elevation. In these closely and equally ribbed individuals nearly or quite all of the ribs commence or start at the apex, are present in the adolescent shell, and are developed and maintained or continued with the growth of the shell through to maturity.

There is also a rather rare flattened intermediate form between those just described and the common coarsely ribbed ones, which connects the two, that is to say, the *æquilirate* variety with the typical *lecanium*, which has 30 to 40 nearly or quite equal ribs with only occasional inconspicuous inter-ribs or liræ; this variety probably Carpenter was not familiar with, as it is not common.

In the typical *lecanium* which is, so far as my observation goes, the most abundant in individuals, the prominent ribs vary in number from as few as 11 in young shells to 23 or more in adults, the interspaces being filled with fine striæ; it is often the case that the number of the coarse ribs in the same individual, in its earlier stages of growth, is less than the adult shell exhibits, as the coarse ribs often bifurcate at some incremental stage and continue, each part being of equal prominence with the main rib from which they forked or branched. Such instances of *lecanium* as exhibit the fewest ribs, when flattened make

*Mr. Fisher's specimens, though numerous, were, as a whole, rather small; a lot of about 70 not exceeding an average of .49 inch in length.

the variety *palmata*,* of which six examples now before me display from 24 coarse ribs in the largest specimen 1.03 inch in length to only 12 ribs in the smallest which measures only .47 of an inch in length; the exceeding prominence of the ribs in this specimen, projecting greatly beyond the margin, give the edge a digitated appearance, suggesting in miniature some of the Indo-Pacific limpets; for illustration *Patella saccharina* Linnæus.

The various aspects presented by *lecanium* in its numerous varieties and intermediate forms are such, that to quote Carpenter,† "I have found it impossible to separate them," hence my inclusion of his *æquilirata* in the synonymy herein given.

If, as Carpenter says,‡ "*S. maura* Sby., is one of the varieties of this species," and "*S. ferruginea* Rve., is probably described from the intermediate forms" between *S. maura* and *S. palmata*, then these should be added to the synonymy. Carpenter regarded the form *æquilirata* as a Lower Californian rather than a Gulf species.§ He credits it to the northerly stations of Cerros Island (Ayres and Veatch's collections), also to Margarita Bay (Pease shells) where he gives "leviuscula Sby., teste Cuming," as a synonym of it, and he also reports it as from Cape St. Lucas in the Xantus collection.

The Ayres, Veatch, Pease shells may be regarded as inhabiting exterior or ocean stations, being the outer or western coast of the peninsula, while the latter place, Cape St. Lucas as well as the Tres Marias, where both the typical *lecanium* and *æquilirata* variety are found, may be regarded geographically as well as biologically as intermediate middle or common ground, hence the occurrence or presence of both of these forms; or, again, if the æquilirate form should be by some persons viewed as an extra limital aspect of *lecanium*, then perhaps we should include in the group as varieties and therefore synonyms of the southern *S. costata*, a rather small, delicate, closely ribbed æquilirate shell, the ribs fine rather than coarse; this form is reported from Guacomayo (Cuming) Sowerby, and Panama (C. B. Adams); also in the Stearns collection from Panama (Bridges), and Valparaiso (Brannan); Dr. Jones obtained specimens at Payta. Some of the examples of *costata*, the more coarsely ribbed specimens, are so close to the selected delicate examples of *æquilirata* from the Tres Marias as to make it difficult if not impossible to satisfactorily segregate the two, were they mingled without previous marking, many individuals of each run so closely together. The southern *S. costata* is, aside from its inferior size and more delicate sculpture and structure, more helcion-shaped, with the apex more or less recurved and nearer the margin.

* *S. lecanium*, with variety *palmata*, was plentiful at Cape St. Lucas. (Xantus Collection.) B. A. Report 1863, p. 621.

† Maz. Cat., p. 182.

‡ Brit. Assn. Rept., 1863, p. 545.

§ B. A. Report, 1863, p. 626. *Id.* 664, 666, and 676.

In connection with the foregoing on the relations and variations of the west American forms of *Siphonaria*, it will be found on examination that the species or forms of other faunal regions, more or less remote, exhibit the same characters of variation, if not as extreme, nevertheless in a greater or less degree. For this purpose among numbers of specimens compare *S. brunnea* Hanley from Bermuda, etc. (Jones); make a similar comparison with *S. leucopleura* Gmelin from the Viti Islands.

Family TEREBRIDÆ.

TEREBRA (MYURELLA) VARIEGATA, Gray.

Many examples. San Jose Island (No. 56297, U. S. N. M.), La Paz (No. 101719, U. S. N. M.).

The specimens from the first locality are all young shells. Capt. Forrer also reported the above species from La Paz, where Fisher collected a varietal form (No. 101720, U. S. N. M.).

TEREBRA (SUBULA) STRIGATA, Sowerby.

= *Buccinum elongatum*, WOOD. + *T. zebra*, KIENER. + *T. flammea*, LESSON.

One specimen, beach; Tres Marias.

Rarely known to occur so far to the north; "common at Panama."* Dr. Jones collected two examples at Payta, Peru, and Cuming collected it at the Galapagos.

Family CONIDÆ.

CONUS DALLI, Stearns.

Seven examples.

Tres Marias, Maria Madre (Nos. 37417, 37418, U. S. N. M.). Since describing this form in April, 1873,† numerous specimens have passed under my examination, and confirm the conviction which led me at the time to regard this embroidered cone of the Mazatlan province as a new species. I see no necessity for modifying the diagnosis or the comments published at that time other than to add what is herein written.

In the collection of Mr. Fred. L. Button, of Oakland, Cal., is a remarkably fine series of young shells which are even more characteristic and distinct from any other of the embroidered cones than are the average adults of *C. Dalli* from *C. textile*, etc., which it occasionally somewhat resembles in pattern and color of markings. Mr. Fisher collected two living and several beach examples at the island of Maria Madre, the principal of the Tres Marias group. The largest, though somewhat rubbed and worn at each extremity, measures long. 2.35, lat. 1.29 inches; if perfect the length would be not less 2.65 inches.

Prof. Verrill refers, probably, to this shell in his "Contributions to

* Hinds, in Proc. Zool. Soc., 1843, p. 160.

† Proc. Cal. Acad. Sciences.

Zoology, etc.," No. VI, in Am. Jour. Sci. and Arts, Vol. XLIX, March, 1870, p. 227.

CONUS VITTATUS, Lamarck.

Five specimens, Tres Marias (No. 88312, U. S. N. M.).

The National collection contains further examples of this beautiful species. Mr. Fisher's are of the beautiful pink variety, and his shells range from juniors to adults.

Fine large specimens of the purple colored shells from Panama are in the collection (No. 37435, U. S. N. M.). These were collected by Bridges.

CONUS PURPURASCENS, Broderip.

Numerous specimens.

San Josef Island; Port Escondido (No. 37410, U. S. N. M.); Los Animas Bay (No. 37416, U. S. N. M); Angeles Bay; Tres Marias (No. 37415, U. S. N. M.); also from Sta. Margarita Island (No. 10239, U. S. N. M.). The *Albatross* collectors obtained numerous examples on the beach at the latter place.

CONUS PURPURASCENS, Broderip.

Var. ? = *scalptus*, REEVE.

One example (No. 37407, U. S. N. M.).

The above single specimen was in the Stearns collection from Acapulco. Reeve's species is apparently a variety of *purpurascens*.

CONUS GLADIATOR, Broderip.

Three examples, living. Tres Marias (No. 37438, U. S. N. M.).

In no respect varying from Panama specimens collected by the late Thomas Bridges.

CONUS BRUNNEUS, Wood.

Two examples.

Tres Marias (No. 37445, U. S. N. M.). Altata (No. 37447, U. S. N. M.). Mr. Fisher's specimens of this species were in fine condition and characteristic. The Museum also contains three other examples from latter place.

CONUS BRUNNEUS, Wood.

Var. = *tiaratus*, BRODERIP.

Two specimens.

Tres Marias (No. 37449, U. S. N. M.). Found with the typical *brunneus* at the same time and in the same place. Agrees with Reeve's figure, Conch. Icon., 143. Reeve regarded it as a variety of the Indo-Pacific *C. minimus* which is found at the Navigator Islands (Upolu) and in the Viti group still further to the southwest, which implies that the suite of *C. brunneus* examined by Reeve was rather limited in number of individuals. See remarks in this connection in my paper on "The

Mollusk fauna of the Galapagos Islands, etc.," Proc. U. S. Nat. Mus., Vol. XVI, pp. 384–385.

CONUS NUX, Broderip.

Five specimens.

Port Escondido and Tres Marias (No. 37458, U. S. N. M.). Santa Margarita Island (1 specimen), *Albatross.*

CONUS PRINCEPS, Linnæus.

A few specimens, Port Escondido (No. 37402, U. S. N. M.); Tres Marias (No. 37401, U. S. N. M.).

Mr. Fisher obtained a few examples of this beautiful shell at the foregoing places. He found them "attached to coral blocks," at Port Escondido; several examples from Carmen Island were received from the Stearns collection (No. 37403, U. S. N. M.), and a rare variety without the usual linear markings, from the same collection, detected at Panama by the well-known collector, Thomas Bridges (No. 37404, U. S. N. M.).

CONUS REGULARIS, Sowerby.

Var. = *C. monilifer*, BRODERIP.

A few examples.

Port Escondido (No. 37391, U. S. N. M.); this form is found also at Carmen Island (No. 37394, U. S. N. M.); and a variety at Pichilinque Island (No. 37392, U. S. N. M.).

CONUS DISPAR, Sowerby.

Var. = *C. monilifer*, BRODERIP, var.

Two examples, Boca de los Piedras (No. 37437, U. S. N. M.).

CONUS ARCHON, Broderip.

Three examples (No. 37397, U. S. N. M.); Manzanillo.

CONUS LUCIDUS, Mawe.

Two specimens; beach. Sta. Margarita Island; *Albatross.* Ranges southerly to the Galapagos Islands.

CONUS INTERRUPTUS, Broderip.

Three specimens, San Lucas Cove; Angeles Bay (No. 37423, U.S.N.M.).

CONUS CALIFORNICUS, Hinds.

One fresh example, Ballenas Bay; *Albatross.*

Family PLEUROTOMIDÆ.

PLEUROTOMA PICTA, Beck.

Four specimens; dredged. San Lucas Cove (No. 55241, U. S. N. M.). The above vary in length from $1\frac{7}{8}$ to $2\frac{9}{16}$ inches; this is a keeled

form, the peripheral carina being the most prominent; between the keels the surface is finely spirally threaded.

PLEUROTOMA (SURCULA) FUNICULATA, Valenciennes.

One specimen at each place.

San Lucas Cove (No. 55235, U. S. N. M.); Loreto. A fine, large, dark, chocolate-colored living example, 2.49 inches in length by .84 inch in breadth, was found, with many other pleurotomids, as above. Though not a rare form, it is apparently less common than its near relative, *P. olivacea* Sby. *P. funiculata*, though a less robust shell and not as coarsely sculptured as *olivacea*, exhibits in a striking degree the characteristic sculpture of *olivacea;* it is generally darker colored, though frequently of an olive green or greenish clay color, sometimes yellowish brown and again dark chocolate. The color in many of the species is so exceedingly variable as to be of little value as a specific distinction.

PLEUROTOMA (SURCULA) OLIVACEA, Sowerby.

One specimen (No. 55233, U. S. N. M.). Boca de los Piedras.

An adolescent example, dredged at the above place, ·94 inch length, of a clear white, without epidermis.

PLEUROTOMA (SURCULA) TUBERCULIFERA, Brod. and Sby.

One specimen. San Lucas Cove (No. 55228, U. S. N. M.).

An exceedingly fine example of this strongly characterized species was obtained with the dredge. It is a rare form and seldom met with in collections.

PLEUROTOMA (SURCULA) MACULOSA, Sowerby.

Five examples dredged (No. 55259, U. S. N. M.). San Lucas Cove. One of these was a fresh, perfect shell.

PLEUROTOMA (DRILLIA) UNIMACULATA, Sowerby.

One specimen. San Lucas Cove (No. 55239, U. S. N. M.).

One example of the above was collected at this place, which seems to be rather the metropolis of pleurotomid forms in this general region. It closely resembles *echinatus* Lam., said to come from New Guinea. *P. unimaculata* is a narrower shell, and has heretofore been credited to the west coast of Central America. They both seem to be very close to the *P. gibbosa* of Kiener. The specimen under review is much nearer to *echinata* Lam. than to Kiener's *gibbosa*, as these two species are represented in the figures given by Chenu, Manual, Vol. I, figures 646 and 650. *Unimaculata* is an unfortunate name, as names based on color markings frequently prove to be; for in the instance before me, there is not only a large brownish spot on the basal whorl, but all of the numer-

ous nodes are spotted above and below, and there are revolving bands of the same color, especially seen on the basal volution.

PLEUROTOMA (DRILLIA) INCRASSATA, Sowerby.

=*D. Bottæ*, Val., TRYON.

One example from each locality.

Mazatlan, Henry Edwards; San Lucas Cove, Fisher (No. 55252, U. S. N. M.).

The Mazatlan example was collected and presented to the writer by his esteemed friend, the late Henry Edwards, so well known as an excellent entomologist and actor.

(His magnificent collection of insects has recently become the property of the American Museum of Natural History, New York.)

PLEUROTOMA (DRILLIA) MAURA, Sowerby.

Several specimens.

San Lucas Cove, dredged off San Marcos Island (No. 55237, U. S. N. M.).

Five examples, imperfect and dead, were obtained by dredging at this place. The largest measures 2.50 long., lat., .63, aperture 1.16 inches; the others, without making allowance for the erosion of the apex, measure, respectively, 2.09, 2.06, 1.94, and 1.84 long. inches. A comparison of the specimens shows that they run quite closely in sculpture, varying but little; in color they range, as do several of the related forms, from dark chocolate to a yellowish or sienna-brown. The late Mr. Tryon kindly compared the above with the specimens in the Philadelphia Academy's collection, and returned the following note:

"Pl. maura, Sowb. Reeve, sp. 47, 'Isle of La Plata;' and exactly like a specimen in our museum received from Sowerby."

Worn specimens sometimes exhibit a whitish line following the suture, on the upper whorls and just below the knobs on the body whorl. Reeve gives a figure of this species in his *Conchologia Systematica*, but the fine sculpture shown in said figure is not so clearly exhibited in heavy adult specimens.

Family CANCELLARIIDÆ.

CANCELLARIA (APHERA) TESSELLATA, Sowerby.

Several examples. La Paz Harbor, on a small island (No. 46273, U. S. N. M.).

Many specimens of this rare and peculiar form were obtained as above indicated by Mr. Fisher. The figure No. 1841 in Chenu's Manual, Vol. I, is apparently drawn from a young specimen.

Family OLIVIDÆ.

OLIVA VENULATA, Lamarck.

Numerous examples.

(Nos. 32401, 32402, 32416, 32431, U. S. N. M.) La Paz; Los Animas

Bay; Mulege Bay and Tres Marias. Capt. Forrer collected the above at La Paz; Loreto, Gabb.

This species exhibits extreme variation. In fact, the *Olives* from the Gulf region with the exception of two or three species are not easy to determine. Reeve makes the above as well as *O. araneosa* Lam., *O. Timorea*, *O. obesina*, and *O. pindarina* as synonyms of *O. reticularis*, the well-known Antillean species. I have never met with an example from the West coast that so closely resembled *reticularis* as to suggest such a connection. Carpenter makes *O. Melchersi* Mke., 1851, include *O. angulata* junior, *O. subangulata*, *O. Cumingii*, and *O. polpaster*. His *O. intertincta* is nothing but a variety of *Melchersi* and three specimens recorded by him as "*? intertincta*" were found upon examination to be, (1) *elegans*, and (2) *irisans*, both Indo-Pacific forms. I am quite sure, however, that this must have been in some way a blunder on the part of an assistant. The La Paz examples (No. 32402, U. S. N. M.) are typical. *O. venulata* runs all the way from closely reticulated zigzag waves or Vs on a lightish warm ground with a purple or brownish-purple stain on the terminal part of the columella, to shells that are a warm cream-yellow, sometimes without any of the V-shaped pencilings and sometimes with the same, but subordinated more or less to the general yellowish tone of the surface. Again the Vs are absolutely wanting and the markings are longitudinal, having somewhat of a ligneous aspect, resembling the graining of wood, with darker umber-colored zones blending and softening down to the lighter tint of the ground work or general color. Examples thus colored are the *ligneola* of Reeve (Mus. Steere), and the same author's *O. Cumingii* is still another aspect. The opposite extreme of coloration is seen in the beautiful dark, nearly black variety which has received the name of *oriole*. In these the Vs can generally be seen under the rich glaze that characterizes the numerous forms and varieties of this so-called species. Often in the point of the VVs, there is a nebulous roundish spot, such as would occur in painting, by the paint or color running off of the brush and filling up the sharp angle on the inner side of the point of the V. This gives a beautiful spotted effect in some examples, and occurs as a feature more or less conspicuous in many of the West Coast olives. The examples from Los Animas Bay (No. 32438, U. S. N. M.) suggest *Julietta* by their dotted flames. At Boca de los Piedras, Fisher obtained numerous examples (No. 32416, U. S. N. M.) of the short, rather stumpy, light-colored variety, with rather obscure sienna-yellow markings, (VVs) on a rich creamy yellow ground. Carpenter has compared this variety to the *reticularis* of the Caribbean region, but the two are readily separable by any moderately intelligent expert. Fisher's Boca shells vary in size from .36 minimum to 1.12 maximum in length. The purplish chocolate stain at the base of the columella is quite a

permanent character and is present in the smallest as well as the largest individuals.

OLIVA ANGULATA, Lamarck.

Two specimens.

La Paz (No. 32420, U. S. N. M). Sta. Margarita Island (2 beach), *Albatross*. Small examples sometimes exhibit a facies suggestive of *O. polpaster* Duclos, or it may be said on the other side that occasional heavy examples of *O. polpaster* resemble young individuals of *O. angulata*.

OLIVA SPLENDIDULA, Sowerby.

Two specimens. Tres Marias.

One of Mr. Fisher's specimens measured 2 inches in length. This is an exceedingly beautiful as well as a rare species, and easily distinguishable from any other of the genus. Of the large and beautiful *Oliva porphyrea*, so highly prized by amateurs, and frequently used as a mantel ornament, Mr. Fisher did not obtain any examples. It is quite common, compared with *splendidula*.

OLIVA SUBANGULATA, Philippi.

Three specimens. La Paz; Mulege Bay.

OLIVANCILLARIA (AGARONIA) TESTACEA, Lamarck.

Two examples. Gulf of California (No. 32452, U. S. N. M.).

OLIVELLA GRACILIS, Gray.

Three young specimens. Mulege Bay (No. 47257, U. S. N. M.).

OLIVELLA UNDATELLA, Lamarck.

Five specimens. Altata (No. 47222, U. S. N. M.).

OLIVELLA DAMA, Mawe.

Numerous examples.

Mulege Bay (No. 47230, U. S. N. M.); Los Animas Bay; Loreto; Angeles Bay; San Lucas Cove; La Paz.

OLIVELLA CYANEA, Reeve.

= *O. puelchana*, ORBIGNY, Reeve's Monog., Pl. XXIV, figs 70^a, 70^b, 70^c.

Abundant, living. Tres Marias (No. 47254, U. S. N. M.).

Family HARPIDÆ.

HARPA CRENATA, Swainson.

[not *H. crenata* GRAY or *H. crenata*, REEVE, of authors.]

= *H. scriba*, VAL. + *H. gracilis*, B. & S. + *H. rosea crenata*, GRAY. + *Buccinum roseum*, WOOD. + *Buccinum minus*, WOOD; [not *Harpa minor*, MART.] + *H. Riviolina*, LESSON. + *H. rosea*, var. KIENER. + *H. Mexicana?* Jay's Cat. + *H. testudinalis?* *Id.*

Numerous specimens. Tres Marias.

Collected here by Fisher; previously received by me from the islands in all stages of growth. *Harpa rosea*, with which this Gulf shell is sometimes confounded, is an African species, which in maturity nearly always exhibits the rose-pink color which is generally confined to the earlier stages of *H. crenata*; in young shells of the latter it is apparently a constant character. The ribs in *crenata* are much less developed than in the other Harps; fresh living shells are frequently met with of a dull reddish-ashen surface, but very slightly enameled, while the delicate waved markings are nearly obsolete. Highly colored and glossy individuals are very beautiful, though even in such examples the enamel is less brilliant than in most of the species. Carpenter (in B. A. Report, 1863, p. 122), referring to the prices of certain West American shells as noted in the British Museum copy of the "Tankerville catalogue," 1825, quotes *H. crenata* 45*s*. = $11.25, and *Conus regius* (= *C. princeps*) is given at £5 5*s*. = $26.25. The peculiar *Lucina* (*Miltha*) *Childreni* Gray, a form that is rare even to this day, is quoted at £10 10*s*. = $52.50.

Family MARGINELLIDÆ.

VOLVARINA VARIA, Sowerby.

One example. Mulege Bay (No. 12260, U. S. N. M.).

Although Fisher's collection contained only one, a dead shell, it is not an uncommon form from the Gulf region. It it credited by Carpenter to Cape St. Lucas and to the West Indies.

Family VOLUTIDÆ.

VOLUTA (ENÆTA) CUMINGII, Broderip.

+ *E. Pederseni*, VERRILL.

Several specimens. San Lucas Cove (No. 46380, U. S. N. M.).

Mr. Fisher collected many examples of this interesting form at the above place, which well illustrate the differentiation between the mature and adolescent stages of growth. Numerous specimens collected by various parties or procured from sailors employed in the Gulf trade especially during the Franco-Mexican war, when the commerce between San Francisco and west Mexican Gulf ports was at its height, have passed under my examination. Prof. Verrill many years ago described *E. Pederseni* from specimens collected by Capt. Pedersen, but I am inclined to regard it as only a variety of *Cumingii*. *Voluta Cumingii* has since been detected as far north as Magdalena Bay (No. 102548, U. S. N. M.) by Mr. C. H. Townsend, of the U. S. Fish Commission.

Family TURBINELLIDÆ.

MELONGENA (SOLENOSTEIRA) MODIFICATA, Reeve.

= *Siphonalia modificata*, REEVE, and of authors.

Many specimens.

La Paz; San Lucas Cove; Los Animas Bay; Angeles Island; Boca de los Piedras; Tres Marias (No. 46754, U. S. N. M.).

As to the relationship of the above form see Dall's remarks in the Transactions of the Wagner Institute, Philadelphia, volume 3, part 1, p. 122, August, 1890, and my paper on Dr. Jones' collection of South American shells in Vol. XIV, Proc. U. S. National Museum, p. 323.

Family MITRIDÆ.

MITRA LENS, Wood.

Common, between tide marks. La Paz; Tres Marias.

MITRA EFFUSA, Swainson.

Rare. A solitary specimen.

Mulege Bay (No. 46409, U. S. N. M.); Dr. Gabb also collected an example somewhere on the Gulf side of the peninsula.

MITRA (CANCILLA) SULCATA, Swainson.

=*M. gigantea*, SWAINSON. +*M. Hindsii*, REEVE. +*M. attenuata*, SWAINSON. +*M. funiculata*, REEVE.

Several specimens. San Lucas Cove (Nos. 46405, 46406, U. S. N. M.).

The synonymy as above is given by Tryon. (Manual, Monograph of *Mitridæ*, p. 139.)

MITRA (STRIGATELLA) TRISTIS, Broderip.

Numerous fine specimens.

Mulege Bay (No. 46393, U. S. N. M.); Los Animas Bay (No. 46390, U. S. N. M.).

Fisher's specimens were for the most part small or immature; his largest example measured long. 1.17, lat. .45 inch.

Family FASCIOLARIDÆ.

LATIRUS (LEUCOZONIA) CINGULATA, Lamarck.

One example, Tres Marias (No. 47124, U. S. N. M.).

Occurs also at Mazatlan in the Gulf, thence southward to Panama where it has been collected by Cuming, C. B. Adams, Bridges, and others. This form varies considerably in height of the spire as well as in the length of the horn. It has been erroneously placed in the genus *Monoceros*, Lam. (=*Acanthina*, Fischer, in Adams genera), also by C. B. Adams in his "Shells of Panama," and by Chenu (Manual, tome 1, p. 169, fig. 832). Calkins in his Catalogue of the Marine Shells of Florida, etc., Proc. Davenport Acad. Nat. Sci., Mach 29, 1878, has erroneously included this species, confounding it quite likely through general similarity of name with the very different Caribbean *Latirus cingulifera*, Lam., and further added to the confusion by including the

"genus Monoceras, Lam.," in his catalogue and placing *Leucozonia* as a subgenus thereunder. He remarks that "it is a Panama species found by me at the southern extremity of Florida."

The necessity for calling attention to this unfortunate "muddle" again at this late day, is apparent to any student who has observed how persistently errors of this class find a lodgment in the literature, long after they have been pointed out or exposed. It is well known that neither *Leucozonia cingulata* nor any representative of the group *Monoceros* have up to this time been detected on the Atlantic side of the continents, and it is particularly remarkable so far as regards the latter genus.

LATIRUS CERATUS, Wood.

Numerous specimens, living. Tres Marias (No. 47125, U. S. N. M.).

Many fine examples were detected by Mr. Fisher living in the crevices of the ledges and dead on the beaches. The average dimensions of the Fisher shells is, long. 2.69, lat. 1.44 inches.

FUSUS DUPETITHOUARSII, Kiener.

Many specimens.

La Paz and San Lucas Cove; Loreto (No. 32336, U. S. N. M.); Carmen Island (No. 32334, U. S. N. M.). Of this fine species the examples range from 1.76 to 7.50 inches in length. Compared with specimens of *F. multicarinatus* from Yokohama, a form regarded by the late Mr. Tryon as the same as *F. Reevianus* Phil., and which he further suggests as the same as *F. Nova-Hollandiæ* Rve., I find the sculpture rather finer and the canal (not a fixed character in the spindle shells) proportionally longer in the Japanese species. Though running very close, the two may be regarded as valid species. In some individuals of the Gulf form the longitudinal ribs which extend from suture to suture on the upper whorls become reduced to mere tubercles on the periphery of the two last or larger whorls.

FUSUS AMBUSTUS, Gould.

Six examples.

San Lucas Cove (No. 32340, U. S. N. M.).

Since the publication of Mr. Dall's paper* "On the Californian species of Fusus" and Mr. Tryon's Monograph,† I have carefully examined the various species included therein that inhabit the region referred to in this paper. Mr. Fisher collected eleven specimens of the form now regarded as *ambustus*. In the various related material before me, I found but little difficulty in segregating these. The two largest meas-

* Proc. Cal. Acad. Sci., March 19, 1877.

† Manual of Conch, vol. III, pp. 58–64.

ure respectively 2 and 2.05 inches in length; placed side by side with examples of *F. Dupethithouarsii* of same length it will be seen that the former is generally of slenderer habit and a more graceful form, as Tryon remarks. Fine mature specimens are often bluish-white inside of the aperture.

FUSUS CINEREUS, Reeve.

Several specimens. La Paz (No. 32354, U. S. N. M.); San Lucas Cove (No. 32353, U. S. N. M.).

The three La Paz shells are small, of the four Cove specimens, two are adult and two juniors. Rather a rare shell in collections. The National Collection contains examples received from other sources. From Panama, collected by Bridges, several examples are registered under the numbers 32356 and 32357. It is found at other places in the Gulf region.

PISANIA (TRITONIDEA) INSIGNIS, Reeve.

= *Pisania insignis*, Reeve, in S. I. Check List 1860, and Carpenter's Mazatlan Catalogue.

Not common; one specimen. San Lucas Cove (No. 46736, U. S. N. M.). The Fisher example from the above locality is destitute of the longitudinal ribs. Sta. Margarita Island (two beach shells), *Albatross*.

PISANIA (TRITONIDEA) GEMMATA, Reeve.

Three examples. Mazatlan (No. 46746, U. S. N. M.), Henry Edwards. This species appears to be of infrequent occurrence.

ENGINA CARBONARIA, Reeve.

Three juniors, live shells. Mulege Bay (No. 46688, U. S. N. M.). A rare species.

ENGINA CARBONARIA, Reeve; var. FUSIFORMIS, Stearns.

One specimen, living, dredged. San Lucas Cove (No. 102620, U. S. N. M.).

An elongated rather coarsely sculptured shell, quite deceptive at first sight. Outer lip simple, as if immature; in strong contrast with the ordinary chunky, solid, heavy-lipped type of the species.

MACRON ÆTHIOPS, Reeve.

+*M. Kellettii*, Hinds; Stearns, Proc. Phil. Acad. Nat. Sciences, pp. 397, 398, Pl. VII, figs. 3, 4, 5.

Common; fine specimens. San Quentin Bay (Nos. 60074, 60075, 60076, U. S. N. M.).

Numerous living examples of this variable shell were collected by Mr. Fisher on "mud flats" in said bay, which indisputably connect the above forms. Reeve's description and figure indicate an example in

which the entire surface was broadly and deeply channeled or grooved, agreeing perfectly with specimens in the National collection (60074) which measure 2.9 inches in length by 1.92 inch in width; from this size younger examples as small as 1 inch in length by 0.58 inch in width (the outer lip thin at this age), show the same characters. In *Kellettii* (60076) Hinds' form, the shell exhibits only three of these channels, near the base of the body whorl. Mr. Fisher's specimens prove that the grooving is an uncertain character. The number of individuals collected by him was fortunately ample enough to settle all doubts and prove that the two forms as above should be united under one specific name; as Mr. Reeve's appears to be the first in order of time, it must be adopted. The National Museum series exhibits all of the intermediate forms or varieties; the connecting links (60075) were received not only with the Fisher shells but from Hemphill and other sources.

The shells of the foregoing when living or fresh are covered with a thick blackish epidermis, which is apt to peel or flake off when very dry. The epidermis has the same character in the rare *Mitra Belcheri*, in common with other West American related forms, and we may presume it lives in similar muddy stations.

Examples of *M. Æthiops* of the form that is grooved throughout have been collected at Cerros or Cedros Island, on the ocean side of Lower California; it was collected years ago by Capt. Scammon, in Scammon's lagoon. The late Prof. W. M. Gabb found it at San Juanico, on the ocean side of the peninsula, in 1867, and Henry Hemphill has contributed specimens to the National Museum, collected by him at San Ignacio lagoon (No. 105432, U. S. N. M.); Manuel lagoon (No. 105433, U. S. N. M.); Point Abreogos "around rocks" (No. 105434, U. S. N. M.) also at Scammon's lagoon (No. 105428, U. S. N. M.). Ballenas Bay (No. 102256, U. S. N. M.), U. S. Fish Commission, *Albatross*.

Family NASSIDÆ.

NASSA TEGULA, Reeve.

=*N. tiarula*, KIENER.

Abundant.

La Paz; Mulege Bay (No. 46616, U. S. N. M.). Los Animas Bay (No. 46615, U. S. N. M.); Loreto. This variable species is exceedingly numerous at many places in the Gulf region and elsewhere on the shores of Lower California; it exhibits many interesting and suggestive varieties. The usual Gulf form is of a pale, dingy yellow or yellowish-white color, in some specimens running into an ashen-blue on the last half of the final whorl, with sometimes two, more rarely, three dark color bands, the upper one interrupted by the sculpture, which latter consists of 8 or 9 strong longitudinal ribs, interrupted and broken into nodules by a transverse groove, just below the suture; the ribs evanesce on the last third of the basal whorl, showing three or four strong nodules

only, with a nearly smooth area below. Otherwise sculptured with ten or more sharp, revolving striæ; the varying prominence of the longitudinal and transverse sculpture, combined with variableness in form—some shells being robust or "chunky," others elongated—produces, as may be supposed, many varieties. A dwarfed form is often met with. A variety occasionally noticed resembles one aspect of the Gulf of Mexico *Nassa vibex;* specimens of these occur at La Paz.

In the more northerly examples from San Diego and thereabout the longitudinal and transverse sculpture is less variable, being more nearly equal in prominence; the shells are darker colored, with usually a conspicuous dark spot over the mouth. Some of the San Diego specimens closely resemble certain occasional individuals of *Nassa lirata* Dkr., from Japan. In an interesting paper by F. P. Marat (May, 1876), "On the variation of sculpture exhibited in the shells of the Genus Nassa," the author remarks:

> *N. tegula* (Reeve pl. 15, fig. 99, *a* and *b*), is simply coronated at the sutures, but when the ribs are completed it becomes the *N. coronula, A. Ad.* Some of my varieties are only half ribbed, and others are scarcely ribbed beyond the tubercles.

NASSA CORPULENTA, C. B. Adams.

Several specimens. Tres Marias (No. 46606, U. S. N. M.). A rather rare shell.

NASSA LUTEOSTOMA, Broderip and Sowerby.

Several examples.

La Paz; St. Josef Island; Los Animas Bay (No. 46608, U. S. N. M.); Francisquita Bay; Angeles Bay; Boca de los Piedras; Tres Marias.

NASSA COMPLANATA, Powis.

=*N. scabriuscula*, C. B. ADAMS.

Numerous (Nos. 46644, 46646, U. S. N. M.). Los Animas Bay; Mulege Bay.

NASSA COMPLANATA; var. MAJOR, Stearns.

Abundant (No. 75155, U. S. N. M.). Los Animas Bay.

The above is a much larger form than the average of typical *complanata* and much coarser in sculpture, and some of the examples are as large as small specimens of *tegula;* it suggests on a casual glance *N. vibex*, of Floridan waters.

NASSA BRUNNEOSTOMA, Stearns.

Nassa brunneostoma, STEARNS, Nautilus, May, 1893; Proc. U. S. Nat. Museum, Vol. XVI, 1893, pp. 344, 345.

Abundant.

Gulf of California near the mouth of the Colorado River (No. 37239, U. S. N. M.); Guaymas (Nos. 23721, 55951, U. S. N. M.).

Collected by Dr. Edward Palmer. An exceedingly pretty and characteristic species, allied in a general way to Reeve's *tegula* and Powis's *complanata*.

Family COLUMBELLIDÆ.

COLUMBELLA HÆMASTOMA, Sowerby.

Not common; beach. San Lucas Cove.

COLUMBELLA FUSCATA, Sowerby.

Common, living. Tres Marias; Loreto.

COLUMBELLA MAJOR, Sowerby.

Common, living. Port Escondido; Tres Marias and elsewhere. Fisher's shells from the first locality are of the small variety.

COLUMBELLA (ANACHIS) CORONATA, Sowerby

A few examples. Mulege Bay; Tres Marias.

Compared with related forms this species is apparently rather rare, not only at the above place, but throughout the Gulf region.

COLUMBELLA (ANACHIS) GASKOINII, Carpenter.

A. tæniata, PHILIPPI.

Examples (No. 48256, U. S. N. M.). Mazatlan, Henry Edwards, January, 1873. A rare and very pretty species.

COLUMBELLA (ANACHIS ?) PARVA, Sowerby.

Two specimens. Mazatlan, Hy. Edwards (No. 48270, U. S. N. M.).

COLUMBELLA (ANACHIS) LYRATA, Sowerby.

Examples, beach. Loreto.

COLUMBELLA (ANACHIS) NIGRICANS, Sowerby.

Examples. Loreto.

COLUMBELLA (ANACHIS) SERRATA, Carpenter.

Beach specimens. Loreto.

COLUMBELLA (NITIDELLA) CRIBRARIA, Lamarck.

Common.

La Paz; San Lucas Cove; Los Animas Bay, Angeles Island; Tres Marias (Nos. 48333, 48334, U. S. N. M.); Boca de los Piedras.

Two well-marked varieties, one of a dark chocolate-red, with light spots; the other sienna yellow, with light spots; the latter appear to be more truncated than the first; both of them are on an average rather larger than the usual run of Nicaraguan examples. Occurs also at

Panama, the Galapagos Islands, on the Florida Keys, in the Antilles, and was found to be common at Porto Grande (No. 125323, U. S. N. M.), Cape de Verde Islands by the Eclipse Expedition to West Africa, in 1889.

COLUMBELLA (META) CEDONULLI, Reeve.

=*Conella cedonulli*, of authors.

Numerous examples.

Port Escondido (No. 48318, U. S. N. M.); San Josef Island; Loreto; San Lucas Cove; Los Animas Bay; Mulege Bay; Tres Marias, also at Carmen Island. This form is conspicuous from its numerous and frequently beautiful color varieties. A portion of the Fisher specimens came from the first locality, a single colony. They were all of the same general color, being blotched and spotted with dark brown and yellowish white in varying proportions. In fresh specimens the epidermis around the spire has sometimes a plaited and tufted aspect coincident with the incremental lines.

COLUMBELLA (STROMBINA) MACULOSA, Sowerby.

Seven specimens.

Tres Marias (No. 48306, U. S. N. M.); Loreto; Carmen Island (No. 48303, U. S. N. M.); fine examples of this graceful shell were collected by Mr. Fisher, in some instances measuring 1.35 inches in length. It is the commonest species of the genus on the West coast.

Family MURICIDÆ.

Subfamily MURICINÆ.

MUREX PLICATUS, Sowerby.

Three examples.

La Paz (No. 46757, U. S. N. M.); San Lucas Cove; Loreto; Mulege Bay (No. 46758, U. S. N. M.).

Capt. Forrer obtained this species at La Paz.

MUREX (CHICOREUS) PALMA-ROSÆ MEXICANA, Stearns.

Chicoreus palma-rosæ Mexicana, STEARNS, Proc. U. S. Nat. Museum, Vol. XVI, 1893, pp. 345-346.
?=*M. palma-rosæ*, LAMARCK, var.
?=*M. affinis*, REEVE.
?=*M. Steeriæ*, REEVE.

A single example (No. 46803, U. S. N. M.); in fair condition. Tres Marias.

MUREX (PHYLLONOTUS) BICOLOR, Valenciennes.

Young shells; several examples. La Paz and elsewhere.

The specimens submitted to me by Mr. Fisher were young fresh

examples only from 1.14 to 1.23 inches in length. At this early stage it is nearly impossible to determine under which of the following specific names to place them. While I am inclined to regard them as the juniors of *bicolor*, first, from the general aspect leaning toward said species, and, second, because *bicolor* is the more abundant of the three, there is, nevertheless, a reasonable doubt. We have as closely related forms, *P. bicolor* Val., *P. brassica* Lam., and *P. erythrostoma* Swains.

The latter is apparently a pale variety of *P. bicolor*, of which numerous examples were in my collection and many more have passed through my hands.

In paragraph 60, on page 559 of Carpenter's "Report (1863) to the British Association," he refers to Sowerby's monograph with comments thus "?=*bicolor*, var." which it may be. I am inclined to regard it as a variety of *M.* (*Phyllonotus*) *brassica.*

MUREX (PHYLLONOTUS) PRINCEPS, Broderip.

Single example. La Paz (No. 47172, U. S. N. M.).

The solitary specimen before me is only 1.10 inches in length. The sharpness of sculpture and the elaborate arborescent fringing of the varices in adolescent specimens produce a general effect, which, when compared with heavy adult individuals, is quite likely to mislead those who are not familiar with the West American species in their various stages, and the character of their variation. It is not unlikely that many of the species made by the older authors are really immature varietal forms or geographical varieties. *Murex nitidus*, Brod. (Conch. Ills., fig. 4), Sowerby remarks as being "probably a variety of the last [*M. princeps*] in a young state."

The late Thomas Bridges collected numerous specimens of *princeps* on the coast of Nicaragua at San Juan del Sur, or in that immediate neighborhood. Prof. C. B. Adams did not report it from Panama in the catalogue of his collection from that place. The Nicaraguan examples, so far as I have observed, differ from those of the Gulf region in the same general way as do the adult specimens of *P. radix* from Panama from the Gulf forms of the same which the late Dr. Carpenter catalogued in his "Mazatlan Mollusca" as "*P. nigritus*, Meusch.," and in the S. I. check list as "*P. nigritus*, Phil." The southern shells of both *princeps* and *radix* are generally more stumpy and solid. Though some of Prof. Adams's specimens of *P. radix*, Carpenter says in his review* of Adams's catalogue, "are remarkably fine, more nearly resembling the Gulf *nigritus* than the heavy stumpy shells usually seen, * * * *Phyllonotus radix* and *nigritus* graduate into each other almost as freely as the latter does into *ambiguus*." The last is one of Mr. Reeve's species based on a variety of *radix*, which, being the older name, must stand, and includes also as synonyms *P. nigritus*, Phil. of

* Proc. Zool. Society, London, June, 1863.

Meusch., and *P. ambiguus*, Reeve. The number of varices, though constant within certain limits, is not so persistent and rigid a character as to be of specific value as between the forms referred to by the authors above quoted, some of whom seem to have held rather arbitrary notions as to what constitute a species.

MUREX (PHYLLONOTUS) BRASSICA, Lamarck.

A few examples. Magdalena Bay; La Paz (No. 47172, U. S. N. M.). Mulege Bay.

MUREX (PHYLLONOTUS) RADIX, Gmelin.

Var.=*nitidus* BRODERIP.
+*nigritus* MEUSCH.
+*ambiguus* REEVE.

Two beach shells. Sta. Margarita Island, *Albatross*.

OCINEBRA LUGUBRIS, Sowerby.

Proc. Zool. Soc., London, 1832, p. 175.—Conch. Ill., fig. 26, REEVE, Icon. sp. 143. *Murex erinaceoides*, VAL., Recueil d'observations, etc., II, 302, 1833. =*Murex Californicus*, HINDS, Proc. Zoöl. Soc., London, p. 128, 1843, Voyage Sulphur t. 3, f. 9, 10. =*Murex Californicus*, REEVE, Conch. Icon. sp. 144. =*Murex (Ocinebra) erinaceoides*, VAL. (=*M. Californicus*, HINDS), STEARNS, Proc. Phil. Acad., 1878, pp. 395–396.

La Paz, Fisher (No. 46767, U. S. N. M.). Attention is called to my remarks on the foregoing in the Proc. U. S. National Museum, Vol. XVI, 1893, pp. 346, 347.

OCINEBRA (MURICIDEA) SQUAMULIFER, Carpenter.

?=*M. fimbriata*, A. ADAMS, var.

Several fine examples (No. 46779, U. S. N. M.). Port Escondido; San Lucas Cove.

Very close to *M. hexagonus* Lam. Tryon remarks it is undoubtedly the same species. I have not seen a sufficient number of the Antillean form to hazard an opinion.

EUPLEURA MURICIFORMIS, Broderip.

Common.

San Lucas Cove, opposite Marcos Island (No. 32310, U. S. N. M.).

One example measures 1.64 inches in length.*

Subfamily PURPURINÆ.

PURPURA PATULA, Linnæus.

Two examples. Tres Marias (No. 32141, U. S. N. M.); also Socorro Island (No. 32140, U. S. N. M.).

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* In connection with this species attention is called to Dall's paper in the Proc. U. S. National Museum, Vol. XIV, pages 173–191, 1891.

This last was collected by the late A. J. Grayson, the well known ornithologist.

PURPURA COLUMELLARIS, Lamarck.

Many examples. Tres Marias (No. 32142, U. S. N. M.).

Very heavy solid specimens, of a dwarfed habit and rather elevated spire, of a total length of from only 1.03 to 1.05 inches, were collected at these islands, being about one-half of the size of usual adult examples, which measure long, .2 inches or over.

A variety intermediate between *columellaris* and *patula* is sometimes met with (No. 32143, U. S. N. M.). It is not so heavy or solid as the former and heavier than *patula*, with the protuberance on the columella less conspicuous than is usual in *columellaris*.

PURPURA KIOSQUIFORMIS, Duclos.

= *Cuma kiosquiformis*, Duclos and of authors.

One exceedingly fine specimen. Boca de los Piedras (No. 60065, U. S. N. M.).

The shells from the Gulf region compared with Panama examples appear to have a more regular growth; the pointed knobs are less produced, and the adults, average, of larger size. Henry Edwards collected some very fine specimens at Mazatlan, while at that place several years ago collecting insects; examples of these he kindly contributed to my collection.

PURPURA HIPPOCASTANEUM, Linnæus.

One specimen living.* Mulege Bay (No. 89655, U. S. N. M.).

The black-mouthed variety generally known as *P. bitubercularis* Lamarck.

An Indo-Pacific species. How came it here?

The occurrence of *Cassis vibex* on the Tres Marias, beach, and subsequent detection at La Paz (crab shells), has led me to include the above Polynesian purpuroid in Fisher's list. Its occurrence here may be accidental.

PURPURA BISERIALIS, Blainville.

Numerous examples. Loreto, Gabb. Ballenas Bay; Sta. Margarita Island, *Albatross*.

The Santa Margarita specimens include both the coarsely-sculptured form and the variety, wherein the principal transverse ridges are hardly broken into knobs. This species seems to be very abundant at this place, and exhibits all the varieties to which Carpenter has referred in his Mazatlan Mollusca.

PURPURA TRISERIALIS, Blainville.

Four examples.

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* Previously noted by me in Proc. U. S. Nat. Museum, Vol. XVI, 1893, p. 347.

Tres Marias (No. 32152, U. S. N. M.); La Paz, Capt. Forrer (No. 32151, U. S. N. M.); also at Sta. Margarita Island (beach) *Albatross*.

PURPURA TRIANGULARIS, Blainville.

Examples. Loreto.

MONOCERAS TUBERCULATUM, Gray.

+ *Purpura muricata*, GRAY.

One example from each of the following places:

Tres Marias, Fisher (No. 60012, U. S. N. M.), and La Paz, Capt. Forrer. Sta. Margarita Island, *Albatross*, three beach shells. This species ranges southerly as far as Peru and extends also to the Galapagos Islands. Two remarkable varietal specimens of this species have been brought to my notice by Miss Cooke, of San Diego. One of these is 4½ inches long, the other nearly as large, and suggests a still greater range of variation approaching the species known as *M. grande*. The variability exhibited by different specimens in the prominence of the horn has been previously mentioned.

A young individual which I have examined, measuring only .76 inch in length shows the horn; in another over 2 inches in length it is barely perceptible. Gabb collected this at San Bruno, and two examples from this locality are contained in the U. S. Nat. Museum; (No. 32154.)

MONOCERAS LUGUBRIS, Sowerby.

Several specimens.

Tres Marias (No. 60017, U. S. N. M.). Ballenas Bay, *Albatross*, abundant; it occurs also at Sta. Margarita Island. Many examples of a rather elongated, less solid and robust form than those usually seen from other localities in the general region. These have a rich purple mouth merging into dark chocolate. The largest measured long., 1.05; lat., 58; long., 0.97; lat., 0.61; the latter the smallest. The above is rather a variable species.

SISTRUM FERRUGINEUM, Reeve.

Common. Point Escondido; St. Josef Island; Los Animas Bay; Loreto.

Subfamily CORALLIOPHILINÆ.

CORALLIOPHILA (RHIZOCHILUS) NUX, Reeve, *ex* Carpenter.

=*Murex nux*, REEVE, Conch. Icon. pl. 38, sp., 181. + *R. aspera*, REEVE. = *M. (Ocinebra) nux*, H. and A. ADAMS. Genera Vol. I, p. 75. = *Purpura costata*, BLAINVILLE. *Corralliophila costata*, BLAINVILLE; CARPENTER, Mazatlan shells, p. 484. = *Cuma costata*, AUCT.

Four examples (No. 32167, U. S. N. M.). St. Josef Island; San Lucas Cove; Tres Marias.

The spire which in young specimens is short becomes elevated

in adults, and shows three revolving keels or ribs on the basal whorl, varying in prominence in different individuals, and traversed and more or less interrupted by 11 to 12 longitudinal ribs, which, at the points of intersection with the transverse keels, produce moderately rough spinose processes; in fine and old specimens these are quite sharp, otherwise sculptured with narrow, close, scabrous revolving ribs. A rather rare form, undoubtedly purpuroid. Compare with *Purpura gallea* from Cuba. Large specimens look very much like some of the so-called Cumas. Tryon's figures do not represent such fine examples as these collected by Fisher, though the national collection contains specimens that agree with the figures referred to, that have been received from other sources.

Superfamily PTENOGLOSSA.

Family SCALIDÆ.

OPALIA CRENATOIDES, var. INSCULPTA, Carpenter.

One example. Angeles Bay (No. 46260, U. S. N. M.).

Superfamily TÆNIOGLOSSA.

Family TRITONIDÆ.

TRITON (LAMPUSIA) VESTITUM, Hinds.

One specimen, dead. Tres Marias (No. 32329, U. S. N. M.); also Panama, T. Bridges (No. 32320, U. S. N. M.). Two examples.

Likely to be confounded with the Indo-Pacific *pileare*, which it much resembles. A rare species.

RANELLA NANA, Broderip and Sowerby.

REEVE, Conch. Icon; Monog. Ranella, Pl. VI, figs. 29*a*, 29*b*.

One specimen; San Lucas Cove (No. 32315, U. S. N. M.).

A rare species, heretofore reported from San Blas, Hinds; Mazatlan, Melchers; Panama Cuming; also at the latter place by C. B. Adams, who found two examples, both crab shells; one specimen in the Stearns collection was collected at Panama by the late Thomas Bridges (No. 32314, U. S. N. M.).

Family CASSIDIDÆ.

CASSIS (CASMARIA) VIBEX-MEXICANA, Stearns.

Casmaria vibex-mexicana, STEARNS, Proc. U. S. Nat. Museum, Vol. XVI, 1893, p. 348.

One example, a crab shell (No. 88831, U. S. N. M.); Maria Madre, Tres Marias; La Paz, Belding.

CASSIS (LEVENIA) COARCTATA, Sowerby.

Numerous specimens.

Tres Marias (No. 47146, U. S. N. M.). Sta. Margarita Island (common),

Albatross. This form is rather common in the Gulf of California region, but really fine examples are rare.

ONISCIDIA TUBERCULOSA, Reeve.

One example. Tres Marias (No. 47143, U. S. N. M.).

A common form in the Gulf region. Occurs also in the Galapagos Islands.

Family DOLIIDÆ.

DOLIUM (MALEA) RINGENS, Swainson.

One perfect example; many fragments.

Sta. Margarita Island, *Albatross.* The above example, though only $1\frac{3}{4}$ inches long, is mature. This species is apparently common at this place. It has been reported from the Galapagos Islands.

Family CYPRÆIDÆ.

CYPRÆA (LUPONIA) ISABELLA-MEXICANA, Stearns.

Luponia Isabella-Mexicana, STEARNS, Proc. U. S. Nat. Mus. 1893, pp. 348–349, fig. 5, pl. 50. =*C. controversa,* GRAY, STEARNS, in Proc. Phila. Acad. Nat. Sci. 1878, p. 399.

Several specimens. Tres Marias (Nos. 46581, 46582, U. S. N. M.).

CYPRÆA (LUPONIA) ALBUGINOSA, Mawe.

Several examples. Tres Marias, Fisher (No. 46587, U. S. N. M.). La Paz, Forrer. Fisher collected many fine living specimens at the former place.

CYPRÆA (LUPONIA) SOWERBYI, Kiener.

=*C. zonata,* LAMARCK.

Several specimens.

Port Escondido; Loreto; Los Animas Bay (No. 46593, U. S. N. M.). Santa Margarita Island (beach), *Albatross.*

Many fine examples were collected at the above places by Mr. Fisher. Adults vary in size from long .91 to 1.81 inches.

CYPRÆA (ARICIA) ARABICULA, Lamarck.

A few living specimens.

Port Escondido; and Maria Madre, Tres Marias. Extends southward to Acapulco, thence to Payta, South America.

CYPRÆA (TRIVIA) SANGUINEA, Gray.

Not common, beach. Tres Marias (No. 46307, U. S. N. M.).

This species has a southerly range as far as Panama and the Galapagos Islands.

CYPRÆA (TRIVIA) SOLANDRI, Gray.

A few examples.

Magdalena Bay; Loreto. Sta. Margarita Island, living, *Albatross.* Ranges from Santa Barbara Islands to Acapulco and Panama.?

CYPRÆA (TRIVIA) RADIANS, Lamarck.

A few specimens.

Tres Marias (No. 46320, U. S. N. M.); also from Altata, on the Gulf (No. 46321, U. S. N. M.), A. J. Gove. Reported from Guacomayo and said to extend to "Ecuador and Peru."

CYPRÆA (TRIVIA) PULLA, Gaskoine.

Rare, beach, three examples.

Tres Marias (No. 46312, U. S. N. M.); Mazatlan (No. 46313, U. S. N. M.). The single specimen from Mazatlan was collected by the late Henry Edwards. A rare species. Also credited to the Galápagos Islands.

CYPRÆA (PUSTULARIA) PUSTULATA, Lamarck.

Six examples,

Tres Marias (No. 46334, U. S. N. M.); also Altata (No. 46335, U. S. N. M.), A. J. Gove. Ranges southerly to Acapulco and Panama.

ERATO COLUMBELLA, Menke.

Rare, living, two examples. Mulege Bay (No. 46346, U. S. N. M.).

This locality carries the above further up the Gulf than before reported. Its northerly limit appears to be Monterey, Cal. Occurs also at Acapulco, to the south.

Family STROMBIDÆ.

STROMBUS GALEATUS, Wood.

Three examples, immature, beach, fresh. Tres Marias (No. 55644, U. S. N. M.).

In the adolescent stage the above, like other strombs, resembles the cones. The young of this species, as seen in the foregoing example, is beautifully mottled with white, on a warm yellowish-brown ground. In point of size this is the west coast analogue of the Antillean *S. gigas;* the largest specimen of *galeatus* that I have seen is much smaller than the average of the West Indian form; they are entirely unlike in specific characters, such as sculpture, color, etc., the Antillean species far surpassing its west coast relative in beauty of coloring as well as in size. *S. galeatus* is less numerous in the region where it occurs than is *S. gigas* in Antillean waters.

STROMBUS GRANULATUS, Swainson.

Several specimens.

Pichilinque Bay; also one fossil example, Santa Margarita Island, *Albatross.*

STROMBUS GRACILIOR, Sowerby.

Three beach shells. Pichilinque Bay, *Albatross.*

Family CERITHIIDÆ.

CERITHIUM MACULOSUM, Kiener.

Common.

Tres Marias (No. 32265, U. S. N. M.); La Paz, Fisher, Forrer. Pichilinque Bay, Ballenas Bay, and Santa Margarita Island, *Albatross.* Many fine examples with the sculpture prominent, and the knobs sharply pointed. Has a wide geographical range, extending northerly on the outer shore of the peninsula of Lower California, midway to the boundary line of California; thence southerly to Ecuador and the Galápagos Islands. Altata is another locality; (No. 32254, U. S. N. M.)

CERITHIUM STERCUS-MUSCARUM, Valenciennes.

Abundant (No. 32276, U. S. N. M.).

San Lucas Cove and Los Animas, Fisher; La Paz, Forrer. Pichilinque Bay, *Albatross.*

CLAVA GEMMATUS, Hinds.

=*Vertagus gemmatus*, HINDS, Carpenter's check list, etc., and authors.

Not infrequent.

Tres Marias (No. 32294, U. S. N. M.), Cape St. Lucas, and La Paz. This form is quite common at Acapulco, where I obtained numerous examples in 1868.

CLAVA (LIOCERITHIUM) INCISUM, Sowerby.

Numerous specimens.

La Paz; San Lucas Cove; Los Animas Bay; Loreto; Angeles Island; Mulege Bay; San Francisquita Bay (No. 32291, U. S. N. M.); Boca de los Piedras, and the Tres Marias; the latter locality somewhat doubtful.

Fisher collected many fine, large specimens of this. When full grown it is a rather rare form. Immature examples are not uncommon in collections, and do not exhibit the special character which indicates *Pyrazus.* Fig. 1895 in Chenu's Manual, Vol. I, is a poor representation of this species. Individuals vary in measurement as follows: Long., .94, lat., .25 inch, with 10 whorls; long., .69, lat., .26 inch, with 8 whorls; long., .50, lat., .20 inch, with 8 whorls.

The short, stumpy fellows suggest another or different species. These have been named *C. curtum* Sby., or *C. euros* Bayle.

CERITHIDEA MAZATLANICA, Carpenter

Common.

La Paz and elsewhere in the Gulf region. Ballenas Bay, abundant, *Albatross*.

CERITHIDEA ALBONODOSA, Carpenter.

Several examples.

San Juanico, and other points on the outer coast of Lower California. Both this and *mazatlanica* may be varieties of the more northern form *sacrata* Gould.

Family MODULIDÆ.

MODULUS CERODES, A. Adams.

Numerous examples. Tres Marias (No. 46953, U. S. N. M.).

This pretty and not very common form is apparently rather numerous at these islands, and at a few other points on the shores of the Gulf; obtained at Pichilinque Bay by the *Albatross* collectors. It occurs at the Galapagos Islands.

MODULUS DISCULUS, Philippi.

A few specimens.

Tres Marias (No. 46957, U. S. N. M.), not numerous; the foregoing species appear to be distinct, without connecting varieties. *M. disculus* is by far the more restricted in distribution. It is found also at Mazatlan, Acapulco, and Panama.

MODULUS CATENULATUS, Philippi.

A few examples. Tres Marias. Less common than the others. Occurs at Mazatlan, Guaymas, etc.

Family VERMETIDÆ.

VERMETUS (PETALOCONCHUS) MACROPHRAGMA, Carpenter.

Two specimens. Tres Marias; Los Animas (No. 9502, U. S. N. M.).

VERMETUS (SERPULORBIS) SQUAMIGERUS, Carpenter.

Two specimens.

Sta. Margarita Island (No. 102398, U. S. N. M.), and at Pichilinque Island (No. 117971, U. S. N. M.), *Albatross*.

VERMETUS (SERPULORBIS) PELLUCIDUS, Broderip and Sowerby.

One example. Pichilinque Bay, *Albatross*, on *Pecten subnodosus*.

VERMETUS (SERPULORBIS) PELLUCIDUS, Broderip and Sowerby. Var. = *eburneus*, REEVE.

Station 2828, 10 fathoms, off Lower California, attached to *Spondylus princeps; Albatross.*

BIVONIA COMPACTA, Carpenter. (?)

Examples. Sta. Margarita Island, *Albatross.*

Family TURRITELLIDÆ.

TURRITELLA GONIOSTOMA, Valenciennes.

Several examples.

San Josef Island (No. 9485, U. S. N. M.); San Juanico; also at La Paz, Capt. Forrer.

TURRITELLA TIGRINA, Kiener.

Two examples. San Juanico; Altata (No. 9472, U. S. N. M.).

Family LITTORINIDÆ.

LITTORINA ASPERA, Philippi.

Abundant. Santa Maria Bay (No. 46963, U. S. N. M.).

The specimens from this locality are numerous, typical, and fine; many of them strong, heavy shells.

LITTORINA CONSPERSA, Philippi.

Numerous examples.

Santa Maria Bay; Tres Marias (No. 47001, U. S. N. M.). Not common at the first place, but abundant at the latter. A variety, apparently of this species, occurs at Payta, South America.

Family SOLARIIDÆ.

SOLARIUM GRANULATUM, Lamarck.

Three examples.

La Paz (Nos. 46293, 42694, U. S. N. M.); also at Loreto and Magdalena Bay (No. 46307, U. S. N. M.).

TORINIA VARIEGATA, Lamarck.

A few specimens.

Port Escondido; Boca de los Piedras; Tres Marias (No. 46299, U. S. N. M.). La Paz, Forrer.

Family CALYPTRÆIDÆ.

CRUCIBULUM IMBRICATUM, Sowerby.

Not uncommon.

Tres Marias (Nos. 60241, 60245, U. S. N. M.); Santa Margarita

Island, common on beach, *Albatross;* San Juanico; Galapagos Islands, and coasts of Ecuador and Peru.

A dark brown specimen of this fine species, 0.80 inch in len th from the first locality. The collection contains examples which measure 2.39 inches long. In such large specimens the sculpture is very strong and the somewhat irregular radiating ribs are proportionately more conspicuous than in small specimens; in the latter, however, the details of the finer, wrinkled sculpture are more distinct. A great number of synonyms have been made that I will not here repeat, but refer to Carpenter's Mazatlan Catalogue, p. 287, and to my paper on the Galapagos (*Albatross*) shells, in the Proceedings, U. S. National Museum, 1893, Vol. XVI, 398 *et seq.*

CRUCIBULUM SPINOSUM, Sowerby.

Common (No. 60229, U. S. N. M.).

Tres Marias; Loreto; common everywhere. Santa Margarita Island, common on beach, *Albatross.* From Monterey, Cal., to Peru, and in the Galapagos Islands this species is found; it is a generally and widely distributed form.

CREPIDULA UNGUIFORMIS, Lamarck.

Common.

Tres Marias (No. 12485, U. S. N. M.); La Paz (No. 12497, U. S. N. M.); Captain Forrer.

Particularly fine examples from the inside of the mouth of *Oliva venulata.*

CREPIDULA DORSATA, Brod.; var. LIGULATA, Gould.

One example. Tres Marias (No. 60259, U. S. N. M.); frequent in the Gulf at many places.

CREPIDULA RUGOSA, Nuttall-Reeve.

Two specimens. Altata (No. 12496, U. S. N. M.). The above is ob- ably a varietal aspect of Sowerby's *Crepidula onyx.*

GALERUS MAMILLARIS, Broderip.

One example from each place.

Tres Marias (No. 60253, U. S. N. M.); Altata (No. 60255, U. S. N. M.). Recently detected at Long Beach, on the coast of Los Angeles County, Cal.

Family AMALTHEIDÆ.

AMALTHEA BARBATA, Sowerby.

Two specimens.

Tres Marias (No. 32566, U. S. N. M.). Occurs also at the Galapagos Islands and on the coast of Ecuador.

AMALTHEA SERRATA, Carpenter.

Four examples. Tres Marias (No. 32575, U. S. N. M.).

Ranges northerly along the coast of California proper, and southerly to (?) Panama.

Family NATICIDÆ.

NATICA CATENATA, Philippi.

Five specimens. Gulf of California (No. 46435, U. S. N. M.).

NATICA CHEMNITZII, Pfeiffer.

Eight specimens. Mazatlan, common in many places.

NATICA EXCAVATA, Carpenter.

One specimen, beach. Tres Marias (No. 46346, U. S. N.M.). This is a decidedly rare species.

NATICA ZONARIA, Recluz.

Several examples living. Tres Marias (No. 46443, U. S. N. M.); Carmen Island (No. 46441, U. S. N. M.).

NATICA PRITCHARDI, Forbes.

Numerous specimens.

La Paz; San Lucas Cove; Los Animas; Angeles Island; Boca de los Piedras; Tres Marias; Loreto, etc. A widely distributed form. Carpenter has included under the name of "*maroccana* Chemnitz," the above, as well as *N. unifasciata* Lamarck and *zonaria* Recluz. It is probably true that these are all varieties of one and the same species, but it is a matter of uncertainty as to which of these specific names was first applied to West American shells. *N. maroccana* is credited to the Galapagos Islands.

POLYNICES BIFASCIATA, Gray

Numerous specimens.

La Paz; San Lucas Cove, opposite Marcos Island (Nos. 46453, 46454, U. S. N. M.); Pichilinque Bay, *Albatross*.

Mr. Fisher reported the above as common at La Paz. A fine species, not always *bifasciate*. Occasionally the space between the usual bands on the latter part of the body whorl is filled in with white, thus uniting and forming a single broad band.

POLYNICES UBER, Valenciennes

Common, living and on the beaches.

Mulege Bay (No. 46436, U. S. N. M.); La Paz (No. 46461, U. S. N. M.);

Boca de los Piedras (No. 46459, U. S. N. M.); Loreto; Panama; Payta; Manta; Galapagos Islands. It has a more northerly distribution than herein given.

POLYNICES (LUNATIA) OTIS, Broderip and Sowerby.

Several examples.

Boca de los Piedras (No. 46546, U. S. N. M.); La Paz; Tres Marias; Payta, Peru; Galapagos Islands. At the latter a variety is found which has received the name of *galapagosa*, Recluz, it is pretty close to if not absolutely the same as the following.

POLYNICES (LUNATIA) OTIS, var.=FUSCA, Carpenter.

One specimen at each place Tres Marias (No. 46547, U. S. N. M.); Acapulco (No. 46545, U. S. N. M.). The first example somewhat the worse for the rubbing it got in the surf, resembles the Indo-Pacific form "*N. somiæ* Chemnitz, New Zealand and Viti Islands," etc., so closely that Tryon thought it was that species. It does not approach very closely to *somiæ*, but the importance of an extensive geographical and varietal series was seen in this case, as well as hundreds of others, for it enabled us to connect it without trouble with its geographical congeners. It is with barely a doubt the variety to which Dr. Carpenter gave the name of "*fusca*."

POLYNICES (NEVERITA) RECLUZIANA, Reeve.

Two examples from each of the following places:

La Paz (No. 46533, U. S. N. M.); Tres Marias (No. 46535, U. S. N. M); Boca de los Piedras (No. 75000, U. S. N. M.); San Juanico; Loreto; and elsewhere northerly and to the south. Pichilinque Bay, also fossil on Cerros Island, *Albatross.*

SIGARETUS DEBILIS, Gould.

Infrequent.

La Paz, living (No. 46555, U. S. N. M.); Altata (No. 46553, U. S. N. M.). The nucleus, nuclear whorls, and general aspect of this species is very much like *S. perspectiva* Say of the Florida region.

Superfamily DOCOGLOSSA.

Family ACMÆIDÆ.

ACMÆA DALLIANA, Pilsbry

Manuel Conch., Vol. XIII, p. 13, Pl. VII, figs. 57-60.

Several examples (No. 32614, U. S. N. M.).

Angel Island, Pt. Refugio; also at (?) San Francisquita Bay and (?) Los Animas Bay. Chief examples measured 2.15 long, 1.55 lat. milli-

meters. Sculpture closely resembling that of *A. scabra* Nutt.-Rve., which also occurs in the Gulf region. The above is much longer in proportion to breadth, more ovate and flatter than *scabra* of same size, and the apex is less central than in the latter species.

It may prove to be an extreme varietal aspect of *scabra*.

ACMÆA PATINA, Eschscholtz.

Two juniors.

These are the young of a common varietal aspect of *patina* and were detected at Santa Margarita Islan d (No. 102523, U. S. N. M.), *Albatross*

ACMÆA ASMI, Middendorff.

Common living. Ballenas Bay, *Albatross*.

The above three species may be regarded as northern forms and their southerly limit is probably in this vicinity. So too with *Lottia gigantea*, referred to below.

The following species of the group may on the other hand be considered as more southerly forms and their northerly limit, in a general way in this region.

ACMÆA PEDICULUS, Philippi.

One example. Tres Marias (No. 32612, U. S. N. M.).

ACMÆA FASCICULARIS, Menke.

Several specimens. Tres Marias (No. 32664, U. S. N. M.); Loreto.

ACMÆA DISCORS, Philippi.

Abundant. Tres Marias (No. 32628, U. S. N. M.); San Bruno, Gabb (No. 32645, U. S. N. M.).

ACMÆA ATRATA, Carpenter.

Two specimens.

Tres Marias (No. 32649, U. S. N. M.); one adult and one junior. Acapulco Dall (No. 59671, U. S. N. M.); Cape St. Lucas (No. 59666, U. S. N. M.).

LOTTIA GIGANTEA, Gray.

One beach shell. Ballenas Bay, *Albatross*.

SCURRIA MESOLEUCA, Menke.

Three specimens. Tres Marias (No. 32664, U. S. N. M.).

SCURRIA MESOLEUCA, Menke; var.?= ACMÆA VESPERTINA, Reeve.

Two examples.

Tres Marias (No. 32629, U. S. N. M.); Ventosa Bay, Tehuantepec

(No. 60443, U. S. N. M.), Sumichrast. Common in many places, and more highly colored than is usual with *mesoleuca*.

Family PATELLIDÆ.

PATELLA MEXICANA, Broderip and Sowerby.

One example at each place. Altata (No. 47189, U. S. N. M.), Tres Marias (No. 75002, U. S. N. M.).

Superfamily RHIPIDOGLOSSA.

Family PHASIANELLIDÆ.

PHASIANELLA PERFORATA, Philippi.

One specimen. Tres Marias (No. 55440, U. S. N. M.).

Family TURBINIDÆ.

TURBO (SENECTUS) SQUAMIGER, Reeve.

Two specimens. Tres Marias (No. 59908, U. S. N. M.).

The geographical range of the above extends southerly to Ecuador and Peru, and it is said to occur at the Galapagos Islands. It is a rare species.

TURBO (CALLOPOMA) FLUCTUOSUS, Wood.

= *T. fluctuatus*, REEVE; + *T. Moltkianus*; = *T. Fokkesi*, JONAS; = *T. assimilis*, KIENER, + *T. tessellatus*, KIENER; ? = *T. depressus*, CARPENTER; ? = *T. funiculosus*, KIENER, CARPENTER.

Numerous young specimens.

Tres Marias (No. 59905, U. S. N. M.), Point Escondido and St. Josef Island. This species was collected by the *Albatross* naturalists at Pichilinque Bay (beach), at Santa Margarita Island, where it was found to be abundant, both the simple corded form as well as the strongly sculptured and nodose variety; also at Ballenas Bay.

Dr. Jones collected the above species on the coasts of Ecuador and Peru.

ASTRALIUM (UVANILLA) INERMIS, Gmelin.

One example.

Point San Quentin (No. 59910, U. S. N. M.). The most northerly point at which this form has been detected.

ASTRALIUM (UVANILLA) REGINA, Stearns.

One specimen, living.

Guadalupe Island (No. 135314, U. S. N. M.), Capt. George D. Porter. A beautiful and characteristic species.*

POMAULAX UNDOSUS, Wood.

Not uncommon.

* Preliminary description in "The Nautilus," 1892. Described and figured in the Proc. U. S. Nat. Mus., Vol. XVI, 1893, p. 350.

Ballenas Bay (one junior) and Cerros Island 2 fossil examples *Albatross*. Common in the vicinity of San Diego and San Pedro, as well as on Catalina Island.

Family TROCHIDÆ.

CHLOROSTOMA GALLINA, Forbes.

Three examples. Tres Marias (No. 60040, U. S. N. M.).

The above are young specimens, about one-third mature size.

Also detected at Santa Margarita Island and Ballenas Bay, *Albatross*. An abundant form on Catalina Island and elsewhere at more northerly localities on the mainland.

CHLOROSTOMA GALLINA, *var.* MULTIFILOSA, Stearns.

One example, living.

Guadalupe Island (No. 125315, U. S. N. M.). A fine large form;* entire surface covered with close-set, rather coarse thread-like ridges, that follow the whorls spirally.

CHLOROSTOMA (OMPHALIUS) GLOBULUS, Carpenter.

Abundant. Tres Marias; Point Escondido; St. Josef Island.

Particularly numerous at the Tres Marias. Shell rather flattish when young; transversely finely ribbed; middle portion of whorls somewhat angulated and in some instances carinated, the upper edge of angle or keel broken into roundish nodules. Umbilicus open, large, generally stained with a bright green, otherwise color variable; in this latter respect like *Gibbula varians* Phil., or *Omphalius canaliculatus* Lam., from Europe.

CHLOROSTOMA (OMPHALIUS) FUSCESCENS, Philippi.

Two examples.

San Juanico. Common at Catalina Island and elsewhere along the mainland to the north.

The above is probably the *ligulatum* of Menke, a varietal aspect of *viridulum*.

CHLOROSTOMA (OMPHALIUS) AUREOTINCTUM, Forbes.

Several specimens.

Santa Margarita Island and Ballenas Bay, *Albatross*. Common on Catalina Island.

CALLIOSTOMA VERSICOLOR, Menke.

Living specimens.

*Described and figured in Vol. XVI, Proc. U. S. Nat. Mus., 1893, p. 351. Preliminary description in "The Nautilus," 1892.

Boca de los Piedras (No. 32505, U. S. N. M.); Cape St. Lucas (No. 32506, U. S. N. M.), and elsewhere in the Gulf region.

Family NERITIDÆ.

NERITA SCABRICOSTA, Lamarck

Several examples.

Pichilinque Bay; Santa Margarita Island, *Albatross;* Common also at the Galapagos Islands. Often of very large size; varies much in elevation.

NERITA BERNHARDI, Recluz.

Abundant.

Tres Marias; also Mulege Bay (Nos. 32702, 60337, U. S. N. M.), where it is exceedingly numerous; also at Pichilinque Bay, Ballenas Bay, and Margarita Island, *Albatross.* Common at Panama.

NERITINA PICTA, Sowerby.

Common.

La Paz; Loreto, and elsewhere in the Gulf; frequently exhibits very beautiful color varieties; extends up the outer coast of Lower California, and south to Panama and beyond. Pichilinque Bay, *Albatross.*

Superfamily ZYGOBRANCHIATA.

Family FISSURELLIDÆ.

FISSURELLA NIGROCINCTA, Carpenter.

One example. Gulf of California (No. 59241, U. S. N. M.).

FISSURELLA VOLCANO, Reeve.

=*F. ornata*, NUTTALL.

Abundant.

Tres Marias (No. 48166, U. S. N. M.). San Juanico, Gabb (No. 48165, U. S. N. M.); Ballenas Bay, *Albatross;* Ventosa Bay, Tehuantepec, Sumichrast (No. 60440, U. S. N. M.). Though darker colored than the more northerly Monterey specimens of *F. volcano*, which are nearly white inside and show more or less of a reddish or pinkish color externally, I regard the specimens from the two localities as belonging to the same species. Specimens in the collection from intermediate points seem to connect them.

FISSURIDEA MURINA, Carpenter.

Several examples.

Tres Marias; La Paz, Forrer. Not uncommon elsewhere in and around the Gulf.

[This is the *Glyphis densiclathrata* of Californian conchologists, but not of Reeve; *G. saturnalis* of Pilsbry (Nautilus, v., p. 105), not of Carpenter, and *G. densiclathrata* var. *murina* of Carpenter.—W. H. D.]*

FISSURIDEA INÆQUALIS, Sowerby.

= *Glyphis inæqualis*, SOWERBY.

Frequent.

Tres Marias (Maria Madre), numerous, Fisher (No. 48191, U. S. N. M.); La Paz, Fisher, and Forrer.

FISSURIDEA INÆQUALIS.

Var. = PICA, Sowerby.

One example. Tres Marias (No. 48190, U. S. N. M.).

FISSURIDEA ALTA, C. B. Adams.

=*Glyphis alta*, C. B. ADAMS.

Five specimens. Tres Marias (No. 48195, U. S. N. M.); also Panama, Bridges (No. 48194, U. S. N. M.).

Superfamily EOPLACOPHORA.

Family ISCHNOCHITONIDÆ.

ISCHNOCHITON CLATHRATUS, Reeve.

=*Lepidopleurus pectinulatus*, CARPENTER, Mss. and of authors.

Numerous examples.

Assuncion Island (No. 58852, U. S. N. M.); Todos Santos Bay, Hemphill (No. 58779, U. S. N. M.); Lower California (Nos. 58805, 125596, U. S. N. M). Besides the above the collection has been enriched by a fine series of this species from Mr. Hemphill, who collected them along the ocean shore of the peninsula.

ISCHNOCHITON MACANDREI, Carpenter.

=*C. muscarius*, REEVE; *fide* CARPENTER.

One specimen, imperfect.

Mazatlan (No. 58879, U. S. N. M.). The foregoing was determined by Carpenter; it is quite rare in collections.

ISCHNOCHITON (STENORADSIA) ACRIOR, Carpenter.

Six examples.

San Juanico (No. 58710, U. S. N. M.), also same place (No. 58750, U. S.

* Dall in Proc. U. S. Nat. Museum, Vol. XIV, p. 197–198.

N. M.); the first collected by the late Dr. Gabb in 1867, the last by Mr. Fisher, who also collected it in Magdalena Bay (No. 58845, U. S. N. M.). The National Museum contains, in addition to the foregoing, a very fine series collected by Mr. Henry Hemphill on the outer coast of Lower California.

PALLOCHITON LANUGINOSUS, Carpenter.

Two examples. Loreto (No. 58863, U. S. N. M.) Gabb.

CHÆTOPLEURA BEANII, Carpenter.

One example.

Mazatlan (No. 58874, U.S.N.M.), off of *Patella mexicana;* it was determined by Dr. Carpenter.

Family LOPHYRIDÆ.

CHITON ALBOLINEATUS, Sowerby.

Several examples.

Mazatlan (No. 59230, U. S. N. M.), collected by Henry Edwards; also three specimens Stearns collection (No. 58765, U. S. N. M.), Todos Santos Bay, Lower California.

A very distinct and beautiful species. Reported also from Acapulco. This species shows considerable variation in color markings, some plates being unicolored, others on the same individuals beautifully picked out with white.

Superfamily OPSICHITONIA.

Family MOPALIIDÆ.

ACANTHOCHITES EXQUISITUS, Pilsbry.

Several examples.

Los Animas Bay (No. 58826, U. S. N. M.) very large specimens (Nos. 58874, 58829, and 58828, U. S. N. M.). A fine series of these extraordinary forms all from the same locality, of a delicate lightish sea-green; a beautiful variety of a pale salmon-color or reddish-buff is illustrated by one example (No. 58830, U. S. N. M.); the branches or tufts of long fibrous spiculæ resemble spun glass. This remarkable form is rarely met with in collections and its exact habitat has heretofore been uncertain. Pichilinque Bay, one example on *Margaritiphora fimbriata, Albatross.*

To facilitate reference, the species above listed as occurring at the Tres Marias Islands have been brought together on p. 203.

MOLLUSKS OF THE TRES MARIAS ISLANDS.

1. Mytilus multiformis, Cpr.
2. Byssoarca mutabilis, Sby.
3. Venericardia flammea, Mich.
4. Cardita crassa, Gray.
5. Chione undatella, Sby.
6. Psammobia regularis, Cpr.
7. Orthalicus undatus, Brug.
8. O. undatus var. = ? O. melanocheilus, Val.
9. Siphonaria lecanium, Phil.
10. Conus Dalli, Stearns.
11. Conus vittatus, Lam.
12. Conus purpurascens, Brod.
13. Conus gladiator, Brod.
14. Conus brunneus, Wood.
15. Conus brunneus var.=tiaratus, Brod.
16. Conus nux, Brod.
17. Oliva venulata, Lam.
18. Oliva splendidula, Sby.
19. Olivella cyanea Reeve, var.
20. Harpa crenata, Rumph.
21. Solenosteira modificata, Rve.
22. Mitra lens, Wood.
23. Leucozonia cingulata, Lam.
24. Latirus ceratus, Wood.
25. Nassa corpulenta, C. B. Ad.
26. Nassa luteostoma, Brod and Sby.
27. Columbella fuscata, Sby.
28. Anachis coronata, Sby.
29. Nitidella cribraria, Lam.
30. Meta cedonulli, Rve.
31. Strombina maculosa, Sby.
32. Chicoreus palma-rosæ mexicana, Stearns.
33. Purpura patula, Linnæus.
34. Purpura columellaris, Lam.
35. Monoceras tuberculatum, Gray.
36. Monoceras lugubris, Sby.
37. Rhizochilus, nux, Rve.
38. Triton vestitum, Hds.
39. Cassis vibex-mexicana, Stearns.
40. Levenia coarctata, Sby.
41. Oniscidia tuberculosa, Rve.
42. Cypræa isabella-mexicana, Stearns.
43. Cypræa albuginosa, Mawe.
44. Cypræa arabicula, Lam.
45. Trivia sanguinea, Gray.
46. Trivia radians, Lam.
47. Trivia pulla, Gask.
48. Pustularia pustulata, Lam.
49. Strombus galeatus, Wood.
50. Cerithium maculosum, Kien.
51. Cerithium incisum, Sby.
52. Clava gemmata, Hinds.
53. Modulus cerodes, A. Ad.
54. Modulus disculus, Phil.
55. Modulus catenulatus, Phil.
56. Petaloconchus macrophragma, Cpr.
57. Littorina conspersa, Phil.
58. Torinia variegata, Lam.
59. Crucibulum imbricatum, Sby.
60. Crucibulum spinosum, Sby.
61. Crepidula unguiformis, Lam.
62. Crepidula dorsata var. ligulata, Ged.
63. Galerus mamillaris, Brod.
64. Amalthea barbata, Sby.
65. Amalthea serrata, Cpr.
66. Natica excavata, Cpr.
67. Natica zonaria, Cpr.
68. Natica Pritchardi, Fbs.
69. Lunatia otis, Brod and Sby.
70. Lunatia otis var. fusca, Cpr.
71. Neverita Recluziana, Rve.
72. Acmæa pediculus, Phil.
73. Acmæa fascicularis, Mke.
74. Acmæa discors, Phil.
75. Acmæa atrata, Cpr.
76. Scurria mesoleuca, Mke.
77. Scurria mesoleuca var. ? = vespertina, Rve.
78. Patella Mexicana, Brod and Sby.
79. Phasianella perforata, Phil.
80. Senectus squamiger, Rve.
81. Callopoma fluctuosus, Wood.
82. Chlorostoma gallina, Fbs.
83. Omphalius globulus, Cpr.
84. Nerita Bernhardi, Recluz.
85. Fissurella volcano, Rve.
86. Fissuridea murina, Cpr.
87. Fissuridea inæqualis, Sby.
88. Fissuridea inæqualis var. pica, Sby.
89. Fissuridea alta, C. B. Ad.

It will be seen that the foregoing segregation includes 89 species and varieties of the 294 contained in the general catalogue. The island list is apparently small compared with the latter, and still smaller when compared with the number of species known to exist in the Mazatlan and Panama province. It should, however, be borne in mind that no special effort was made to investigate the Mollusk fauna of the Tres Marias and that the species collected in this little group of islands

were incidentally obtained, or the random collections made, during a very brief stay. Some of the forms are quite rare; these, together with the probability of obtaining other equally rare and desirable species, and the presumption that by systematic search a very large addition may be made to the number now known as occurring, offer a promising return to whoever will make a thorough exploration of these islands.

The following papers, published chiefly in the *Proceedings* of the U. S. National Museum, will be found to contain more or less information relating to the distribution of the species above recorded, as well as to many others that occur on the west coast between Point Conception, California, and the South American coast as far south as 7° 30′ S:

BIBLIOGRAPHY.

DALL, WM. H.: Preliminary report on the collection of mollusca and brachiopida obtained in 1887–'88 by the U. S. Fish Commission steamer *Albatross*.
Proc. U. S. Nat. Mus., XII, pp. 219–362, pls. V–XV, 1889. (No. 773.)

On some new and interesting West American shells obtained from the dredgings of the U. S. Fish Commission steamer *Albatross* in 1888, and from other sources.
Proc. U. S. Nat. Mus., XIV, pp. 173–191, pls. V–VII, 1891. (No. 849.)

Land shells of the genus Bulimulus in Lower California, with descriptions of several new species.
Proc. U. S. Nat. Mus., XVI, pp. 639–647, 1893. (No. 958.)

WILLIAMSON, MRS. M. B.: An annotated list of the shells of San Pedro Bay and vicinity, with a description of two new species by Wm. H. Dall, etc.
Proc. U. S. Nat. Mus., XV, pp. 179–219, 1892. (No. 898.)

STEARNS, ROBT. E. C.: Descriptions of new West American land, fresh-water, and marine shells, with notes and comments.
Proc. U. S. Nat. Mus., XIII, pp. 205–225, 1890. (No. 813.)

List of North American land and fresh-water shells received from the U. S. Department of Agriculture, etc.
Proc. U. S. Nat. Mus., XIV, pp. 95–106, 1891. (No. 844.)

List of shells collected on the west coast of South America, principally between latitudes 7° 30′ S. and 8° 49′ N. by Dr. W. H. Jones, surgeon U. S. Navy.
Proc. U. S. Nat. Mus., XIV, pp. 307–335, 1891. (No. 854.)

Preliminary report on the molluscan species collected by the United States expedition to West Africa in 1889–'90.
Proc. U. S. Nat. Mus., XVI, pp. 317–339, 1893. (No. 940.)

On rare or little-known mollusks from the west coast of North and South America, with descriptions of new species.
Proc. U. S. Nat. Mus., XVI, pp. 341–352, 1893. (No. 941.)

Report on the mollusk fauna of the Galapagos Islands, with descriptions of new species.
Proc. U. S. Nat. Mus., XVI, pp. 353–450, 1893. (No. 942.)

Report on the Land and Fresh-water Shells collected in California and Nevada by the Death Valley Expedition, etc., by Dr. C. Hart Merriam and assistants, etc.
North American Fauna, No. 7, pp. 269–283, 1893.

ORCUTT, CHARLES R.: "The Colorado Desert."
Tenth Annual Report of the State Mineralogist of California, pp. 899–919, 1890.

YATES, DR. L. G.: "The Mollusca of the Channel Islands of California."
Ninth Annual Report of the State Mineralogist of California, pp. 175–178, 1890.

NOTES ON A JAPANESE SPECIES OF REED WARBLER.

By Leonhard Stejneger.

In a recent paper on a collection of Japanese birds submitted to me for examination by the authorities of the Science College Museum, Tokyo,* I described what I considered a new species as *Locustella hondoensis*. At that time the volume for 1889 of the Proceedings of the Zoological Society of London belonging to the Museum was at the Government bindery, and consequently inaccessible to me. Since the publication of the above description, however, I have had access to another copy and find that the naming of this species had already been anticipated by the late Dr. L. Taczanowski. Three males in greatly abraded plumage, collected near Chemulpo, Korea, on July 15, 1887, were at first recorded by him as *Locustella fasciolata*.† The following year, however, he corrected this mistake and named the birds *Locustella pleskei* in honor of Dr. Th. Pleske, the distinguished director of the zoological museum of the St. Petersburg Academy of Sciences.

Notwithstanding the fact that his types, as stated, were adult birds in greatly abraded plumage and that mine (Sc. Coll. Mus., No. 1669) is a young bird, the description furnished by Dr. Taczanowski is sufficient to warrant the conclusion that the two names refer to the same species.

It will be noticed, however, that Taczanowski lays considerable stress upon the alleged larger size of *L. pleskei* as compared with *L. ochotensis*, while, on the other hand, I have regarded them as practically of the same size; but it must be remembered that my bird was a young one, while Taczanowski's types were adult males, and that on account of the abraded state of their wings and tail he allowed for their consequent smaller dimensions.

To supplement the measurements given by me‡ so as to make them more comparable with the dimensions given by Taczanowski, I may state that in the type of *L. hondoensis* the bill from tip to angle of mouth measures 185 mm., and from tip to nostril 105 mm., consequently

* Proc. U. S. Nat. Mus., XVI, 1893, No. 957, p. 633.

† Proc. Zool. Soc., London, 1888, p. 455.

‡ Proc. U. S. Nat. Mus., XVI, 1893, p. 635.

agreeing pretty closely with Taczanowski's data, especially if we bear in mind what an unreliable measurement the former is.

It will be remembered that in my description I stated that the bird in question probably belongs to that group of the genus which has no subapical blackish bar across the tail-feathers, the specimen at my command showing no trace of it, but that I did not venture to be positive about it, as the character is less developed in young birds than in the adults. As Taczanowski's description contains no mention of any subapical black bar, I take it now for granted that the species has none, and the character may be inserted in the diagnosis.

From the above it follows that the Japanese bird must stand as *Locustella pleskei*, Taczan., with the following synonymy:

1888.—*Locustella fasciolata*, TACZANOWSKI, Proc. Zool. Soc., London, 1888, p. 455 (not of Gray).

1889.—*Locustella pleskei*, TACZANOWSKI, Proc. Zool. Soc., London, 1889, p. 620.

1893.—*Locustella hondoensis*, STEJNEGER, Proc. U. S. Nat. Mus., XVI, 1893, No. 957, p. 633.

A REVIEW OF THE FOSSIL FLORA OF ALASKA, WITH DESCRIPTIONS OF NEW SPECIES.

By F. H. Knowlton,

Assistant Curator of the Department of Fossil Plants.

I have recently had occasion, in studying a collection of leaves from Herendeen Bay and interglacial wood from beneath the Muir Glacier, to go over all of the literature relating to the fossil flora of Alaska. As the literature is somewhat widely scattered, a list of all the species of fossil plants heretofore reported from Alaska was compiled as a matter of personal interest and convenience. This was used in determining the collections above mentioned, but after completing the identifications and descriptions of new species detected it was decided to present, in connection with them, a complete compilation of the fossil flora. It was done also with the hope that it might stimulate further investigation of the paleobotany, for from what we know of the distribution of the plant-bearing beds, some of which are represented by single examples, much must remain to be accomplished. This is further shown by the fact that every collection contains a good proportion of new species.

I have first prepared an historical review of works and papers relating to the fossil flora of Alaska, which incidentally shows the geographical distribution of the plant beds. This is followed by a systematic enumeration of the fossil plants, with descriptions of the new species from Herendeen Bay, a table showing the distribution of the plants in other parts of the world, and finally a discussion of the geological age of the beds as indicated by the plants.

HISTORICAL REVIEW.

One of the first accounts of fossil plants in Alaska is given by Dr. C. Grewingk* in his classical history of the Northwest coast of America. This, however, is in the main a compilation, but the sources from which he derived his information are obscure, and I have not been able to find them. It is hardly probable that if found they would prove of much value. He reports coniferous wood from the islands of Kadiak and Unga and the Alaskan peninsula, and dicotyledons (*Alnus*) and conifers

* Beitrag zur Kennt. d. Orographischen u. Geognostischen Beschaffenheit d. Nord-West Küste Amerikas mit Anliegenden Inseln. Verhandl. d. Russ-Kais. Mineralog. Gesell. St. Petersb. 1848–1849, St. Petersb., 1850, pp. 41, 93, 97, 124

(*Taxodium*) from Tschugatsk (Cook Inlet) and Unalaschka. He also mentions a fern from Unga which he supposed to have some resemblance to *Neuropteris acutifolia*. It is probably the same as *Osmunda Doroschkiana* of Göppert, as there is no Carboniferous known from Unga.

A year later, Grewingk again referred* to fossil plants in Alaska, especially to the fossil trunks on Unga Island, but nothing beyond this appears to have been noticed.†

In 1861 Göppert reported‡ upon a small collection of fossil plants obtained in August, 1859, by Lieut. v. Doroshin§ from the islands of Kadiak (lat. 57½°), Uyak|| (lat. 57½°), Atka¶ (lat. 52°), and Kootznahoo** (lat. 57½°). The last of these, Kootznahoo, is in the vicinity of or is a part of Admiralty Island, near Sitka. It afforded 2 species of dicotyledons and a single conifer. Göppert enumerated 11 species, from the combined localities, a number of which were new, but did not give descriptions of them.

In 1866 this same collection was again referred to by Göppert,†† but, unfortunately, the descriptions were not even then supplied, and consequently most of the names of new species remain *nomina nuda*.

In December, 1867, Prof. Oswald Heer, of Zurich, wrote a letter relating to Alaskan plants to Prof. A. E. Nordenskiöld, in Stockholm, which was published in the following year.‡‡ It was an enumeration of the plants brought back by Furuhjelm, and may be considered as an outline of Heer's larger work which appeared in 1869. The plants are arranged according to localities and most of the new species briefly characterized.

In many respects the most important paper on the fossil plants of Alaska was Heer's *Flora Fossilis Alaskana*,§§ which was published in 1869. It was based, as stated above, upon collections brought back by Hjalmar Furuhjelm, of Helsingfors, Finland, who, as governor of the

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*Heidlb. Jahrb. Lit., 1851, p. 235.

†For the modern designations and orthography of Alaskan localities I am greatly indebted to Mr. Marcus Baker, of the U. S. Geological Survey.

‡Ueber d. Tertiärfl. d. Polargegenden: Abhandl. d. Schles. Gesell. f. Vaterländ-Cult., 1861, Heft. II, pp., 201–204.

This paper is also published under the same title in Mélanges Physique et Chimiques tirés du Bulletin de l'Acad. Imp. des sc. de St. Petersbourg. Tome IV, 1860–61, St. Petersb., 1861, pp., 695–712.

§This name is written *Doroschkin* by Göppert, but is an obvious German rendering of the Russian *Doroshin*.

||This is probably from a bay of this name on the northwest coast of Kadiak, but as there are several unnamed islands in this bay it is possible that it may be one of them.

¶This was written *Atha* by Göppert, but *Atka* is the modern spelling.

**Given as *Hudsnoi* by Göppert, which is one of the earlier of the many renderings of the word *Kootznahoo*.

††Abhandl. d. Schles. Gesell. f. Vaterländ-Cult. 1865–'66. Breslau, 1867, p. 50.

‡‡Utdrag ur ett bref af Professor Oswald Heer rovande fossila vexter fråu Nordvestra Amerika, insamlade af Bergmästaren Hj. Furuhjelm. Öfversigt af Vetensaps-Akad. Förhandl. 1868. No. 1, pp. 63–68.

§§Kongl. Svenska Vetenskaps-Akad. Handl. Vol. VIII, No. 4, 1869, pp. 1–41, Pl. I–X.

Russian-American possessions, resided for nearly ten years in Alaska. He made, it appears, a very large collection, most of which was lost on the Mexican coast by the stranding of the ship in which they were being sent home. The specimens which finally reached Europe were obtained from the island of Kuiu,* near Sitka, and from the east side of Cook Inlet, a part coming from English Bay, now better known as Port Graham (lat. 59° 21′; long. 151° 52′), and the rest from near a small stream known as the Neniltschik (lat. 60° 9′). The latter place is about 50 miles north of Port Graham. This paper enumerates 56 species, of which number 19 were then new to science.

In 1871 Eichwald † made a re-examination of the plants collected by Lieut. v. Doroshin that had first been studied, as above pointed out, by Göppert in 1861. Göppert, it will be remembered, did not give figures or descriptions of these plants in his paper. These were supplied by Eichwald, who also made use of Heer's *Flora Fossilis Alaskana* in working over the collection. He enumerated 9 species, 3 of which were newly named, although they had been recognized by Göppert or Heer. Eichwald also gave a list of the species reported from all parts of Alaska by Heer.

In 1882, Lesquereux published a paper entitled "Contributions to the Miocene Flora of Alaska,"‡ which was based upon material brought back by Dr. William H. Dall, then of the U. S. Coast and Geodetic Survey. The plants, which according to Lesquereux, were finely preserved, came from Coal Harbor, Unga Island; Kachemak Bay, § Cook Inlet, and Chignik Bay, Alaskan Peninsula (Lat. 56½°). It enumerated 21 species of which 7 were regarded as new to science. This paper was republished but without the illustrations, in Lesquereux's "Cretaceous and Tertiary Floras," 1883, pp. 257–263.

In 1882, Dr. J. S. Newberry also described new species of fossil plants from Alaska in his paper entitled "Brief Descriptions of Fossil Plants, Chiefly Tertiary, from Western North America." ‖ They were collected by Capt. Howard, U. S. Navy, in Cook Inlet, and Admiralty Inlet,¶ and by the U. S. S. *Saginaw*, in the Kootznahoo Archipelago (Lat. 57° 35′, long. 134° 19′), the last on February 18, 1869. The figures illustrating these plants were prepared and the plates have been engraved and printed since 1871, but have not yet been formally issued. They were designed to form the illustrations of a monograph of the Hayden Geological Survey for which the text was never supplied. A posthumous work, which will embrace them, is being prepared by

* Written *Kuju* by Heer.

† Geognostisch-Palæontologische Bemerkungen Über die Halbinsel Mangischlak u. die Aleutischen Inseln. St. Petersb., 1871, pp. 107–116, Pl. IV.

‡ Proc. U. S. Nat. Mus., vol. v, 1882 (1883), pp. 443–449, Pl. VI–X.

§ Often called Chugachik Bay and so written by Lesquereux.

‖ Proc. U. S. Nat. Mus., vol. v, 1882 (1883), pp. 502–514.

¶ This is presumably an error for Admiralty Island, there being no inlet of this name in Alaska.

Dr. Newberry's successor, Dr. Arthur Hollick, of Columbia College. They are quoted in the present paper as "Plates."

In 1887, Lesquereux published a paper entitled "List of Recently Identified Fossil Plants belonging to the U. S. National Museum, with descriptions of several New Species."* This comprised a large amount of material that had been accumulating in the department of fossil plants since the founding of the Smithsonian Institution. Among them were a few species recorded as having been collected in the vicinity of Sitka, by E. W. Nelson,† and at Cape Lisburn by H. D. Woolfe. The specimens from the latter place appear to have been a part of the collection that was described from the same locality in the following year, they having been accidentally separated.

In 1888, as stated above, Lesquereux published‡ an enumeration of plants obtained at Cape Lisburn by H. D. Woolfe. This collection included 10 species of which number only one was regarded as new to science.

The last paper dealing with pre-glacial fossils is one by Felix§ in which he describes two species of silicified wood. The one obtained by Dr. Krause of Berlin on a basalt mountain south of Danaáka‖ and the other from Copper Island,¶ a small island in the Southwestern part of the Bering Sea.

Mr. F. H. Herrick is the only one, so far as I now know, who has identified any of the interglacial wood. His paper, "Microscopical Examination of wood from the Buried Forest, Muir Inlet Alaska" is published as Supplement III to Harry Fielding Reid's paper "Studies of Muir Glacier, Alaska."** Mr. Herrick identified the wood submitted to him with the tide-land spruce (*Picea Sitchensis*, Carr.) now living about the glacier.

A number of pieces of wood from the buried forest Muir Glacier, obtained in 1892 by Mr. Reid, were submitted to me for examination. The report on them will be published also as an appendix to Mr. Reid's paper, soon to appear in the National Geographic Magazine. The species observed are recorded in their proper systematic position in the present paper.

The latest work dealing with fossil flora of Alaska, and this only incidentally, is the U. S. Geological Survey correlation paper on the

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* Proc. U. S. Nat. Mus., Vol. x, 1887, pp. 21–46, pl. I–IV.

† I am informed by Mr. Nelson that he never visited Sitka and did not bring back any fossil plants from Alaska. This throws doubt on the specimens so recorded, and their locality, and collector remains unknown. I have retained them, however, as recorded by Lesquereux.

‡ Proc. U. S. Nat. Mus., Vol. XI, 1888, pp. 31–33, Pl. XVI, Figs. 1–6; X, Fig. 4.

§ Zeitschr. d. D. geol. Gesell. Vol. XXXVIII, 1886, pp. 483–485.

‖ Fifty miles north of the head of Lynn canal, in Southwestern Alaska.

¶ This is really extra-limital, but has been included as being more nearly related to the Alaskan province than to any other.

** National Geographic Magazine, Vol. IV, 1893, pp. 75–78, figs. 4, 5.

Neocene by Dr. Wm. H. Dall and G. D. Harris.* These authors review at length all fossil-bearing horizons in Alaska, and on a map accompanying the work have colored each locality geologically. They speak of plant beds in various places.

Herendeen Bay, the locality affording the specimens that form the basis of this paper, is on the northern side of the Alaskan Peninsula and forms a branch of Port Möller (Lat. 55° 40′, long. 160°, 40′ ±.) The plants were collected July 28, 1890, by Mr. Charles H. Townsend, resident naturalist of the U. S. Fish Commission Steamer *Albatross*. Mr. Townsend has furnished the following copy of his notes relating to their occurrence:

July 28, 1890.—In making a tramway to the new coal mine just opened here (Herendeen Bay), one of the slaty cuttings exposed a large deposit of fossil leaves and ferns, about a mile from the beach, at the head of a little valley among the hills and within a few hundred yards of the mine itself. We visited the place twice and succeeded in getting a considerable quantity of specimens. Coal veins crop out in several places in the region of this bay. The first output of the new mine is now being used in the furnaces of the *Albatross*, but it is from near the surface and rather slaty.

Mr. Townsend further adds:

The country is mountainous and treeless, but covered with bushes and smaller vegetation. It is in general volcanic and there are lofty peaks, one of which, Pavloff, has been seen smoking.

The material in which the plants are preserved is a fine argillaceous sandstone, very well fitted for retaining the impressions. The vegetable remains are in most cases very numerous, even on small fragments of matrix.

SYSTEMATIC ENUMERATION OF SPECIES.

ALGÆ.

CHONDRITES FILICIFORMIS, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32, Pl. XVI, fig. 1.†

Cape Lisburn; H. D. Woolfe.

CHONDRITES HEERI, Eichwald

EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln, St. Petersb. 1871, p. 111, Pl. IV, fig. 1.
Chondrites sp. HEER, Fl. Foss. Alask., p. 21, Pl. X, fig. 5.

Kachemak Bay; H. Furuhjelm.

The specimens at Heer's disposal were not regarded by him as of sufficient distinctness to permit of specific determination. He remarks that it appears very similar to *C. liasinus* of the Swiss Tertiary, and also resembles forms in the Trias and especially *C. Targionii* of the older Molasse. Eichwald, however, had secured better material and took the opportunity to confer Heer's name upon it. Eichwald's specimens were preserved on the same kind of dark carbonaceous shale as *Taxo-*

* Bull. U. S. Geol. Survey, No. 84, pp. 232–268, Pl. III.

† The bibliographical citations refer exclusively to the occurrence of the various species in Alaska, and are not to be regarded as indicating the synonymy.

dium Tinajorum and he hence regarded the species as belonging to the Miocene, suggesting that it may have been a transition form from the Cretaceous.

EQUISETACEÆ.

EQUISETUM GLOBULOSUM, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 444; Cret. and Tert. Fl., p. 222, Pl. XLVIII, fig. 3.

This species was obtained by Dr. Wm. H. Dall, but the exact locality is not given. As the only localities from which he obtained fossil plants were Cook Inlet, Unga Island, and Chugachik Bay, it most probably came from one of these. It was also obtained in the Bad Lands of Dakota, from which specimens the above-mentioned figure was made.

CALAMITES AMBIGUUS, Eichwald.

EICHWALD, Geognost.-Palæontolog., Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln, St. Petersb., 1871, p. 114, Pl. IV, fig. 9.

Northeastern coast of Alaska north of Cape Jaklök, and south of a small stream of that name; Eichwald.

This is a small fragment only 2 inches long and 1 inch wide, showing 12 longitudinal ribs. It appears to prove, if it is really a calamite, the presence of true Carboniferous strata in Alaska, but it is so very fragmentary that I can not but look upon it with question. Göppert, who first recognized its nature, also claimed to have observed leaves of Sigillaria, but this, too, requires confirmation.

FILICES.

PECOPTERIS DENTICULATA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

PTERIS SITKENSIS, Heer.

HEER, Fl. Foss. Alask., p. 21, Pl. I, fig. 7*a*; EICHWALD, Geognost.-Palæontolog., Bemerk. ü. Halbinsel Mangischlak, und Aleutischen Inseln, St. Petersb., 1871, p. 112.

Island of Kuiu, near Sitka; H. Furuhjelm.

OSMUNDA DOROSCHKIANA, Göppert.

GÖPPERT, Abhandl. d. Schles. Gesell. f. Vaterländ—Cult., 1861, Pt. II, p. 203; EICHWALD, Geognost.-Palæontolog., Bemerk. ü. Halbinsel Mangischlak, und Aleutischen Inseln, p. 112, Pl. IV, figs. 2, 3.

Osmunda Torelli, HEER. LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 444, Pl. VI, figs. 3–6.

Unga Island; Lt. v. Doroshin. Coal Harbor, Unga Island; Dr. Wm. H. Dall.

This species was named by Göppert (l. c.) but not adequately described. It must, however, be the same as the *O. Torelli*, of Lesquereux, from the same place, since both these authors speak of the numer-

ous detached leaflets, occurring embedded in bowlders of carbonate of iron. Lesquereux describes it as follows:

"Most of the leaflets are simple, not lobate, oblong, or ovate-lanceolate entire or merely crenulate on the borders by the impressions of the veins. These leaflets are rarely preserved entire; the borders are often lacerated; they vary from 3.5 cm. to 6 cm. long and 1—2.5 cm. broad. They evidently represent leaflets from Osmunda."

I have ventured to restore Göppert's name, which until now has been a mere *nomen nudum*, for it is almost beyond question the plant that he gave the name to.

ASPIDIUM OERSTEDI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

ASPLENIUM FOERSTERI, Debey and Ettinghausen.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

ASPLENIUM DICKSONIANUM, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

CONIFERÆ.

PINUS! STARATSCHINI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

PINUS, species.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 11.

Port Graham; H. Furuhjelm.

SEQUOIA LANGSDORFII, (Brongniart) Heer.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 10.

Port Graham and Neniltschik; H. Furuhjelm. Herendeen Bay; Chas. H. Townsend.

There are a considerable number of specimens in the collection from Herendeen Bay that are referred with little hesitation to this species. They are seemingly very well preserved, but when examined closely it is found to be difficult to make out the manner of attachment of the leaves. They much resemble some of the branchlets of *Taxodium distichum miocenum* with which they are abundantly associated, but by a study of certain exceptionally well-preserved specimens it is found that

the leaves are decurrent, which clearly separates them from Taxodium. No cones belonging to conifers were found.

SEQUOIA SPINOSA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 504; Plates, Pl. LIII. figs. 4, 5, *ined.*

Cook Inlet, Capt. Howard, U. S. Navy.

This species is described as follows, by Dr. Newberry:

"Branches slender, foliage open, rigid; leaves narrow, acute (acicular), arched upward, appressed or spreading, spirally divergent; staminate flowers in slender terminal aments 2 inches long, two lines wide, anthers few, under peltate connective scales; cones ovate or subcylindrical, composed of rhomboidal or square peltate scales."

The manuscript name on the plates above mentioned is *S. acicularis*, but this is an obvious error.

TAXODIUM DISTICHUM MIOCENUM, Heer.

HEER, Fl. Foss. Alask., p. 21, Pl. I, fig. 6; III, fig. 11*c*; IV, fig. 5 *f. c.*

Port Graham and Neniltschik; H. Furuhjelm. Near Sitka; Lieut. v. Doroshin. Herendeen Bay; Chas. H. Townsend.

TAXODIUM TINAJORUM, Heer.

HEER, Fl. Foss. Alask., p. 22, Pl. I, figs. 1–5.

Port Graham; H. Furuhjelm.

TAXODIUM TINAJORUM, Heer; var.

EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersb., 1871, p. 116, Pl. IV, fig. 4.

Port Graham (English Bay) and Neniltschik; Lieut. H. v. Doroshin.

"The needles are 6 lines long, 1 line broad, and stand 2 lines from each other. The thickness of the leaf-bearing twig is hardly 1 line, being scarcely the width of the leaves."

This form differs from the typical form, according to Eichwald, by the smaller leaves placed at a greater distance from each other and by the well-defined midrib.

GLYPTOSTROBUS EUROPÆUS, (Brongniat) Heer.

HEER, Fl. Foss. Alask., p. 22, Pl. I, fig. 7 *b-f;* III, figs. 10, 11.

Kuin Island, near Sitka; Lieut. v. Doroshin. Neniltschik; H. Furuhjelm. Herendeen Bay; Chas. H. Townsend.

TAXITES OLRIKI, Heer.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 8; II, 5*b*.

Port Graham; H. Furuhjelm.

THUITES (CHAMÆCYPARIS) ALASKENSIS, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 445, Pl. VI, figs. 7-9.

Coal Harbor, Unga Island; Dr. Wm. H. Dall.

GINKGO MULTINERVIS, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 31, Pl. XVI, fig. 6.

Cape Lisburn; H. D. Woolfe.

GINKGO ADIANTOIDES, (Unger) Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. X, 1887, p. 35.

Sitka; E. W. Nelson (?).

A single small doubtful fragment from Herendeen Bay. Collected by Chas. H. Townsend.

BAIERA PALMATA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 31, Pl. XVI, figs, 4, 5.

Cape Lisburn; H. D. Woolfe.

PICEA SITCHENSIS, Carr.

HERRICK, National Geogr. Mag., Vol. IV, 1892, pp. 75-78, figs. 4, 5.—KNOWLTON, Notes on the Examination of a Collection of Interglacial Wood from Muir Glacier, Alaska, MS.

Muir Glacier; Harry Fielding Reid.

TSUGA MERTENSIANA, Carr.

KNOWLTON, Notes on the Examination of a Collection of Interglacial Wood from Muir Glacier, Alaska, MS.

Muir Glacier; Harry Fielding Reid.

CUPRESSINOXYLON ERRATICUM, Mercklin.

FELIX, Zeitschr. d. D. geol., Gesell. Vol. XXXVIII, 1886, p. 484.

Copper Island, southwestern part of Bering Sea; Dr. Krause.

PINITES PANNONICUS, (Unger) Göppert.

GÖPPERT, Abhandl. d. Schles. Gesell. 1861, p. 203.—HEER, Fl. Fos. Alask., p. 23.

Southwestern end of Unga Island; Lieut. v. Doroshin.

PITYOXYLON INÆQUALE, Felix.

FELIX, Zeitschr. d. D. geol., Gesell. Vol. XXXVIII, 1886, p. 483, Pl. XII, fig. 3.

Basalt Mountain, south of Danaáku; Dr. Krause.

CYCADACEÆ.

ZAMITES ALASKANA, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32, Pl. X, fig. 10.

Cape Lisburn; H. D. Woolfe.

PODOZAMITES LATIPENNIS, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 31, Pl. XVI, figs. 2, 3.

Cape Lisburn; H. D. Woolfe.

GRAMINEÆ.

PHRAGMITES ALASKANA, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. I, fig. 12.

Port Graham; H. Furuhjelm.

POACITES TENUE-STRIATUS, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. I, fig. 14; EICHWALD, Geognost.-Paleontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersb., 1871, p. 114, Pl. IV, fig. 7.

Port Graham; H. Furuhjelm. Herendeen Bay; Chas. H. Townsend.

CYPERACEÆ.

CAREX SERVATA, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. I, figs. 13, 13 c. d.

Port Graham; H. Furuhjelm. Herendeen Bay; Chas. H. Townsend.

CAREX, Leaves of.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. X, 1887, p. 36.

Sitka; E. W. Nelson (?).

It is possible that this may be the *C. servata* of Heer, but as it is neither figured nor described I have retained it as probably separate.

ALISMACEÆ.

SAGITTARIA PULCHELLA, Heer.

HEER, Fl. Foss. Alask., p. 25, Pl. I, fig. 15.

Neniltschik; H. Furuhjelm.

SAGITTARIA, species.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. X, 1887, p. 37.

Sitka; E. W. Nelson (?).

IRIDACEÆ.

IRITES ALASKANA, Lesquereux.

LESQUEREUX, Proc., U. S. Nat. Mus., Vol. X, 1887, p. 36.

Cape Lisburn; H. D. Woolfe.

"Leaves thickish, linear-lanceolate, tubulose at apex, narrowed to the base, falcate, æqui-nerved; median nerve obsolete; lateral nerve broad, equal.

"The leaves are comparatively narrow; the best preserved, apparently nearly entire, is 13 cm. long, 15 cm. broad in the middle; nerves

about 1 mm. in width, not very prominent, equal, not separated by intermediate veinlets, very distinct; surface smooth, covered by a thin pellicle of coaly matter, some fragments showing the tubulose point and base. The median nerve is slightly marked in places."

"Comparing these leaves with those of cultivated species of Iris, the essential characters, thickness of leaves, serration, etc., are the same."—[LESQUEREUX.]

SALICACEÆ.

POPULUS LATIOR, Al. Braun.

HEER, Fl. Foss. Alask., p. 25, Pl. II, fig. 4.

Port Graham; H. Furuhjelm.

POPULUS GLANDULIFERA, Al. Braun.

HEER, Fl. Foss. Alask., p. 26, Pl. II, figs. 1, 2.

Port Graham; H. Furuhjelm.

POPULUS BALSAMOIDES, Göppert.

HEER, Fl. Foss. Alask., p. 26, Pl. II, fig. 3.

Populus exima, GÖPPERT, Tert. fl. v. Schossnitz, p. 23; Abhandl. Schles., Gesell., 1861, p. 203.

Port Graham; H. Furuhjelm. Kutznahoo near Sitka; Lieut. v. Doroshin.

POPULUS ZADDACHII, Heer.

HEER, Fl. Foss. Alask., p. 26, Pl. II, fig. 5*a*.

Port Graham; H. Furuhjelm.

POPULUS LEUCOPHYLLA, Unger.

HEER, Fl. Foss, Alask., p. 26, Pl. II, fig. 6.

Populus acerifolia, NEWBY., Later extinct floras of North America, p. 65.

Reported by Heer, but no locality given for Alaska.

POPULUS ARCTICA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus. Vol. V, 1882 (1883), p. 447, Pl. IX, fig. 2.

Chignik Bay; Dr. Wm. H. Dall.

POPULUS RICHARDSONI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 441, Pl. IX, fig. 1.

Chignik Bay; Dr. Wm. H. Dall.

SALIX VARIANS, Göppert.

HEER, Fl. Foss. Alask., p. 27, Pl. II. fig. 8; III, figs. 1–3.

Salix Wimmeriana, GÖPPERT, Tert. fl. v. Schlossnitz, p. 26; Abhandl. Schles., Gesell., 1861, p. 205.

Port Graham and Neniltschik; H. Furuhjelm.

SALIX MACROPHYLLA, Heer.

HEER, Fl. Foss. Alask., p. 27, Pl. II, fig. 9.—EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersb., 1871, p. 113, Pl. IV, fig. 5.

Port Graham; H. Furuhjelm.

SALIX LAVATERI, Heer.

HEER, Fl. Foss. Alask., p. 27, Pl. II, fig. 10.

Port Graham; H. Furuhjelm.

SALIX RÆANA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 447, Pl. VIII, fig. 6.

Cook Inlet; Dr. Wm. H. Dall.

SALIX INTEGRA, Göppert.

GÖPPERT, Abhandl. Schles. Gesell., 1861, p. 202; *op. cit.*, 1867, p. 50.

Neniltschik; Lieut. v. Doroshin.

SALIX MINUTA, new species.

Plate IX, fig. 1.

Leaf small, nearly circular (11 mm. long, 9 mm. wide), slightly heart-shaped at base and very slightly pointed at apex; margin entire below, with few distant teeth in the upper portion; nervation very obscure, consisting of 4–5 pairs of secondaries emerging at a low angle (40°), thence curving along the borders.

This species is founded upon the single specimen figured, and it is with much hesitation that it is described as new. The leaf appears to have been rather thick and firm as are some of the living species found in polar lands.

It is possible that it may not belong to the genus Salix, but as it approaches most closely to some of the forms of *S. polaris* Wahlbg.,* from the diluvial deposits of Spitzbergen, I have decided to describe it under this genus, and wait for future discoveries to prove the truth or error of this disposition. As stated above, the nervation is nearly obsolete, and all that can be made out of the 4 or 5 pairs of secondaries.

The leaf is found associated on the same piece of matrix as specimens of *Taxodium distichum miocenum*, *Paliurus Colombi*, and *Zizyphus Townsendi*.

Salix minuta was obtained at Herendeen Bay by Mr. Charles H. Townsend, of the U. S. Fish Commission steamer *Albatross*. Type, No. 3761 U. S. N. M.

CUPULIFERÆ.

FAGUS ANTIPOFII, Heer.

HEER, Fl. Foss. Alask., p. 30, Pl. V, fig. 4*a*; VII. figs. 4–8; VIII, fig. 1.

Port Graham; H. Furuhjelm.

* Fl. Foss. Arct., Vol. II, Mioc. Fl. u. Fauna Spitzbergens, p. 90, Pl. XVI, figs. 57, 59 *f*.

Five forms may be distinguished according to Heer, embracing *F. lancifolia*, Heer,* *F. pristina*, Sap.,† and *F. emarginata*, Heer.

FAGUS MACROPHYLLA, Unger.

HEER, Fl. Foss. Alask., p. 31, Pl. VIII, fig. 2.

Port Graham; H. Furuhjelm.

FAGUS FERONIÆ, Unger.

HEER, Fl. Foss. Alask., p. 31, Pl. VI, fig. 9.

Port Graham; H. Furuhjelm.

FAGUS DEUCALIONIS, Unger.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 447.

Kachemak Bay, Cook Inlet; Dr. William H. Dall.

CASTANEA UNGERI, Heer.

HEER, Fl. Foss. Alask., p. 32, Pl. VII, figs. 1-3.

Port Graham; H. Furuhjelm; Keku Island, Indian Archipelago?

QUERCUS PSEUDOCASTANEA, Göppert.

HEER, Fl. Foss. Alask., p. 32, Pl. VI, figs. 3-5.

Port Graham; H. Furuhjelm.

QUERCUS FURUHJELMI, Heer.

HEER, Fl. Foss. Alask., p. 32, Pl. V, fig. 10; VI, figs. 1, 2.

Port Graham; H. Furuhjelm.

QUERCUS PANDURATA, Heer.

HEER, Fl. Foss. Alask., p. 33, Pl. VI, fig. 6.

Port Graham; H. Furuhjelm.

QUERCUS CHAMISSONIS, Heer.

HEER, Fl. Foss. Alask., p. 33, Pl. VI, figs. 7, 8.

Port Graham; H. Furuhjelm.

QUERCUS DALLII, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 446, Pl. VIII, figs. 2-5; Cret. and Tert. Fl., p. 259.

Cook Inlet; Dr. William H. Dall.

CORYLUS MACQUARRII, (Forbes) Heer.

Plate IX, fig. 4.

HEER, Fl. Foss. Alask., p. 29, Pl. III, fig. 9, IV, figs. 1-5, 8.—EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln, St. Petersb., 1871, p. 113, Pl. IV, fig. 6.

Port Graham and Neniltschik; H. Furuhjelm. Kuiu Island near

* Heer: Öfversigt af Kongl. Vetenskaps Akad. Förhandl, 1868, p. 64.
† Saporta: Flore de Manosque; Ann. d. Sci. Nat., 1867, p. 69, Pl. VI, figs. 1-3.

Sitka; Lieut. v. Doroshin. Unga Island; Dr. William H. Dall. Herendeen Bay; Charles H. Townsend.

CORYLUS MACQUARRII var. MACROPHYLLA, Heer.

HEER, Fl. Foss. Alask., p. 30, Pl. IV, figs. 6, 7.

Port Graham: H. Furuhjelm.

CARPINUS GRANDIS, Unger.

HEER, Fl. Foss. Alask., p. 29, Pl. II, fig. 12.—LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446.

Kachemak Bay, Cook Inlet; Dr. William H. Dall. Port Graham; H. Furuhjelm.

ALNUS KEFERSTEINII, (Göppert) Unger.

HEER, Fl. Foss. Alask., p. 28, Pl. III, figs. 7, 8.

Neniltschik; H. Furuhjelm.

ALNUS KEFERSTEINII, (Göppert); var.

HEER, Fl. Foss. Alask., p. 28, Pl. V, fig. 9.

Port Graham? H. Furuhjelm.

ALNUS ALASKANA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 509; Plates, Pl. XLVIII, fig. 8.

Kootznahoo Archipelago, latitude 57° 35′, longitude 134° 19′; U. S. steamer *Saginaw*, Feb. 18, 1869.

"Leaf large, oblong-ovoid, acuminate, rounded or slightly heart-shaped at base; nervation crowded, 16 to 18 branches on each side of the midrib, margins set with very numerous, small, uniform, acute teeth."—[NEWBERRY.]

ALNUS GRANDIFOLIA, Newberry.

NEWBERRY, Proc., U. S. Nat. Mus., Vol. v, 1882 (1883), p. 509.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves 4 or 5 inches in length by 3 inches in width, ovate; rounded or wedge-shaped at the base; blunt-pointed at the summit; margins coarsely dentate; nervation strong, crowded; 12 or more parallel branches on either side of the midrib, the intervals between these crossed by numerous parallel, mostly straight nervules, dividing the surface into oblong, quadrangular areoles."—[NEWBERRY.]

ALNUS CORYLIFOLIA, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol v, 1882 (1883), p. 446, Pl. VII, figs. 1–4; Cret. and Tert. Fl., p. 258.

Kachemak Bay, Cook Inlet; Dr. William H. Dall.

ALNUS RUBRA, Bongard.

A branch of this species found protruding from a gravel bank beneath an ice-sheet 70 feet in thickness, on the eastern moraine of

the Muir Glacier. Collected by Miss E. R. Scidmore, of Washington, D. C.

BETULA PRISCA, Ettingshausen.

HEER, Fl. Foss. Alask., p. 28, Pl. v, figs. 3–6.

Port Graham and Neniltschik; H. Furuhjelm.

BETULA GRANDIFOLIA, Ettingshausen.

HEER, Fl. Foss. Alask., p. 29, Pl. v, fig. 8.

Port Graham; H. Furuhjelm.

BETULA ALASKANA, Lesquereux.

LEQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446, Pl. vi, fig. 14; Cret. and Tert. Fl., p. 258.

Chignik Bay, Alaska Peninsula; Dr. William H. Dall.

"Leaves small, round in outline, rounded or truncate at base, deeply, obtusely dentate all around except at the base, turned back or recurved on a short petiole; median nerve distinct, the lateral obsolete; catkins short cylindrical, oblong or slightly inflated in the middle.

"Except that no glands are perceivable upon the stems, this species agrees in all its characters with *Betula glandulosa* Michx. I consider it as identical."—[LESQUEREUX.]

MYRICACEÆ.

MYRICA BANKSIÆFOLIA, Unger.

HEER, Fl. Foss. Alask., p. 28, Pl. II, fig. 11.

Port Graham; H. Furuhjelm.

The affinities of this species, according to Heer, are with *M. Californica* Cham., a species living in California.

MYRICA (COMPTONIA) CUSPIDATA, (Lesquereux) Dawson.

Comptonia cuspidata, LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 445, Pl. vi, figs. 10–12; Cret. and Tert. Fl., p. 258.

Myrica (*Comptonia*) *cuspidata*, LESQUEREUX DAWSON, Trans. Roy. Soc., Canada, 1890, p. 80, fig. 9.

Coal Harbor, Unga Island; Dr. Wm. H. Dall.

"Leaves long, linear or gradually tapering upwards to a terminal narrowly elliptical lobe, pointed or apiculate by the excurrent median nerve; pinnately lobed, lobes coriaceous, convex, subalternate, free at base, irregularly trapezoidal or oblique-oblong, inclined upwards, and sharply acute or cuspidate; primary nerves two, or three in the largest lobes, oblique, the upper curving in ascending to the acumen and branching outside, the lower parallel and curving along the borders, anastomosing with branches of the superior ones, generally separated by simple secondary, short nerves.

"Comparable to *Comptonia acutiloba* Brongt., and other European

Tertiary species of this group, but distinct from all by the large cuspidate lobes turned upwards, etc."—[LESQUEREUX.]

MYRICA (COMPTONIA) PRÆMISSA, Lesquereux sp.

Comptonia præmissa, LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882, p. 445, pl. VI, fig. 13.

Coal Harbor, Unga Island; Dr. Wm. H. Dall.

"Leaves long, linear in their whole length, 5–10 cm. long, 12–15 mm. broad; deeply equally pinnate-lobate; lobes very obtuse or half round, cut to the middle and slightly decurring in their point of connection, the terminal lobes very obtuse; nervation obsolete, substance somewhat thick but not coriaceous.

"This species has its greatest affinity with the living [*Myrica*] *Comptonia asplenifolia* Ait."—[LESQUEREUX.]

MYRICA VINDOBONENSIS, (Ettingshausen) Heer.

HEER, Fl. Foss. Alask, p. 27, Pl. III, figs. 4, 5.

Neniltschik: H. Furuhjelm.

JUGLANDACEÆ.

JUGLANS ACUMINATA, Al. Braun.

HEER, Fl. Foss. Alask., p. 38, Pl. IX, fig. 1.

Port Graham: H. Furuhjelm.

JUGLANS NIGELLA, Heer.

HEER, Fl. Foss. Alask., p. 38, Pl. IX, figs. 2–4.

Port Graham; H. Furuhjelm.

JUGLANS PICROIDES, Heer.

HEER, Fl. Foss. Alask., p. 39, Pl. IX, fig. 5.

Port Graham; H. Furuhjelm.

JUGLANS WOODIANA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 449.

Chignik Bay; Dr. Wm. H. Dall.

JUGLANS TOWNSENDI, new species.

Plate IX, Fig. 5.

Leaf thick, evidently coriaceous, oblique, margin entire; nervation prominent, consisting of a thick midrib and alternate or subopposite secondaries, those on the narrower side of the leaf emerging at a right angle, or even falling below a right angle, those on the other side

emerging at an angle of about 20°, all arching around to near the margin along which they curve until joined to the one next above, the union being affected by a series of simple loops; nervills prominent, approximately at right angle to the secondaries, except when they emerge from the midrib and join the secondary next below, producing triangular or quadrangular areas; ultimate nervation obsolete.

The fragment figured is the only one detected in the collection, and although it appears distinct, is hardly sufficient for proper characterization. It appears to differ markedly from all of the species of this genus described by Heer, from Alaska. (See above.) It is most like *J. nigella* Heer, but differs absolutely in having a perfectly entire margin. *J. acuminata* has an entire margin, but differs widely in nervation, while the remaining species, *J. picroides*, differs in having the margin sharply serrate.

The only fossil species with which I am at present able to compare it is *J. egregia* Lx.,* from the auriferous gravels of California. It much resembles a segment taken from near the base of one of these nearly entire leaves of this species. The nervation is practically the same in both. The margin of *J. egregia* has sometimes a few small teeth, but there is no indication that such was the case in the form under discussion.

Herendeen Bay; Charles H. Townsend. Type, No. 3762, U. S. N. M.

URTICACEÆ.

FICUS ALASKANA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus. Vol. v, 1882 (1883), p. 512; Plates, Pl. LII, fig. 1; LV. figs. 1, 2.

Cook Inlet and Admiralty Inlet; Capt. Howard, U. S. Navy.

"Leaves large, reaching 8 to 10 inches in length and breadth; trilobed, generally unsymmetrical; lobes pointed, usually obtuse; margins entire or locally undulate; nervation strong, conspicuously reticulate; principal nerves three, giving off branches which divide near the margins, sometimes connecting in festoons, sometimes craspedodrome; tertiary nervation forming a coarse network of usually oblong meshes filled with fine polygonal reticulation; upper surface of the leaf smoothe and polished, lower roughened by the reticulation of the nerves."—[NEWBERRY.]

FICUS MEMBRANACEA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 512; Plates, Pl. LIX, fig. 2.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves sensile, 4 to 6 inches in length by 2½ to 3½ in width; ovate, abruptly and usually blunt-pointed, narrowed to the base, generally unsymmetrical, margin entire, nervation delicate, open, camptodrome;

*Mem. Mus. Comp. Zool. Vol. VI., No. 2, p. 36, Pl. IX, fig. 12.

10 or more branches given off on either side of the midrib, curving upward, and forming a festoon near the margin."—[NEWBERRY.]

PLANERA UNGERI, Ettingshausen.

HEER, Fl. Foss. Alask., p. 34, Pl. V, fig. 2.

Port Graham; H. Furuhjelm.

ULMUS PLURINERVIA, Unger.

HEER, Fl. Foss. Alask., p. 34, Pl. V, fig. 1.

Port Graham; H. Furuhjelm.

ULMUS SORBIFOLIA, Göppert.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 447, Pl. IX, fig. 3; Cret. and Tert. Fl., p. 260.

Kachemak Bay, Cook Inlet; Dr. William H. Dall.

EBENACEÆ.

DIOSPYROS STENOSEPALA, Heer.

HEER, Fl. Foss. Alask., p. 35, Pl. VIII, figs. 7, 8.

Neniltschik, H. Furuhjelm.

DIOSPYROS ALASKANA, Schimper.

Diospyros Alaskana, SCHIMPER, Traité d. Pal. Vég., Vol. II, p. 945.
Diospyros lancifolia, LESQUEREUX in Heer, Fl. Foss. Alask., p. 35, Pl. III, fig. 12.

Neniltschik, H. Furuhjelm.

The name given this species by Lesquereux is preoccupied by a living species. It has consequently been changed by Schimper to *D. Alaskana.*

DIOSPYROS ANCEPS, Heer.

LEXQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 448; Pl. X, figs. 1, 2; Cret. and Tert. Fl., p. 261.

Cook Inlet; Dr. William H. Dall.

OLEACEÆ.

FRAXINUS HERENDEENENSIS, new species.

Plate IX, Fig. 7.

Leaflet membranaceous (4 cm. long, 2 cm. wide), nearly regularly elliptical in outline, rounded, almost truncate at base, rapidly narrowed from above the middle to an acuminate apex; margin entire below, sparingly toothed above the middle; midrib strong; secondaries 6–8 pairs, alternate or subopposite, emerging at an angle of about 40°, camptodrome, each one joined to the one next above it by a series of regular loops just inside the margin; slender nerves from the outside

of these loops enter the teeth in the upper part; nervilles mostly percurrent, at right angles to the secondaries; finer nervation obsolete.

This species is represented by two fine leaflets, the one figured being in some respects the more perfect. They appear to have been membranaceous or possibly a little firmer. They are almost regularly elliptical in outline with a few distinct teeth above the middle. As both lack the complete base it is impossible to state anything as to the petiole or manner of attachment. They are very slightly if at all inequilateral at the base.

This species is undoubtedly closely related to *Fraxinus denticulata*, Heer,* from the Miocene of Greenland. Heer's species differ from this, however, in being clearly wedge-shaped at base, in having the margin toothed from near the base, and in having the secondaries usually opposite and at a more acute angle of divergence. It is possible that if there were a larger number of specimens of the species from Herendeen Bay they might be shown to grade more closely into *F. denticulata*, but in absence of these I have preferred to keep them separate.

Among living species the form under discussion approaches closely to some leaflets of *F. Ornus*, L., especially the terminal ones. It is also somewhat like some of the broader leaflets of *F. excelsior*, L., from northern Europe.

Herendeen Bay; Charles H. Townsend. Type, No. 3763, U. S. N. M.

ERICACEÆ.

ANDROMEDA GRAYANA, Heer

HEER, Fl. Foss., Alask., p. 34, Pl. VIII, fig. 5.

Port Graham; H. Furuhjelm.

VACCINIUM FRIESII, Heer.

HEER, Fl. Foss. Alask., p. 35, Pl. VIII, fig. 4.

Port Graham; H. Furuhjelm.

VACCINIUM RETICULATUM, Al. Braun.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 448, Pl. X, figs. 3–5; Cret. and Tert. Fl., p. 261.

Cook Inlet; Dr. William H. Dall.

CAPRIFOLIACEÆ.

VIBURNUM NORDENSKIÖLDI, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. III, fig. 13.

Neniltschik; H. Furuhjelm.

* Fl. Foss. Arct. Vol. I, p. 118, Pl. XVI, fig. 4.

CORNACEÆ.

NYSSA ARCTICA,? Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v., 1882 (1883), p. 447; Cret. and Tert. Fl. p. 261.

Unga Island; Dr. William H. Dall.

CORNUS ORBIFERA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 448, Pl. x, fig. 6; Cret. and Tert. Fl., p. 262.

Cook Inlet; Dr. William H. Dall.

ARALIACEÆ.

HEDERA AURICULATA, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. IX, fig. 6.

Port Graham; H. Furuhjelm.

ONAGRACEÆ.

TRAPA BOREALIS, Heer.

HEER, Fl. Foss. Alask., p. 38, Pl. VIII, figs. 9–14.

Port Graham; H. Furuhjelm.

HAMAMELIDACEÆ.

LIQUIDAMBAR EUROPÆUM, Al. Braun.

HEER, Fl. Foss. Alask., p. 25, Pl. II, fig. 7.

Port Graham; H. Furuhjelm.

ROSACEÆ.

SPIRÆA ANDERSONI, Heer.

HEER, Fl. Foss. Alask., p. 39, Pl. VIII, fig. 3.

Port Graham; H. Furuhjelm.

The affinity of this species is with the living *S. tomentosa*, *L.*, of the Eastern United States.

PRUNUS VARIABILIS, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 509; Plates, Pl. LII, figs. 3–5.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves short petioled, very variable in form; lanceolate or broadly lanceolate, 2 to 3 inches long by 1 to 2 inches wide; acuminate at the

summit, wedge-shaped at base; margins thickly set with minute, acute, appressed teeth."—[NEWBERRY.]

SAPINDACEÆ.

ACER MACROPTERUM, Heer.

HEER, Fl. Foss. Alask., p. 37, Pl. IX, figs. 7–9.

Port Graham; H. Furuhjelm.

ACER TRILOBATUM PRODUCTUM, (Al. Braun) Heer.

Plate IX, fig. 3.

Herendeen Bay; Charles H. Townsend.

The single leaf figured is the only one found in the collection that can be referred to this species. It is a small leaf about 3 cm. long and 2·5 cm. wide, and agrees very closely with some of the figured European specimens referred to this form. It is, for example, especially like figs. 5 and 6 of Pl. CXIV and fig. 7 of Pl. CXV of Heer's *Fl. Tert. Helv.* These are small leaves with short lateral lobes and a prolonged central lobe. The margin is cut by sharp irregular teeth and the nervation, as nearly as can be made out, agrees perfectly with the European forms.

ANACARDIACEÆ.

RHUS FRIGIDA, new species.

Plate IX, fig. 6.

Leaflets firm, thickish, broadly lanceolate in outline, rounded, heart-shaped at base, bluntly acuminate at apex; margin sparingly toothed above the middle, teeth pointing upward; midrib distinct, straight; secondaries 7–8 pairs, alternate or subopposite, emerging at an angle of 50°, camptodrome, arching in regular bows just inside the borders, and thus joining the one next above; nervills percurrent, usually approaching a right angle to the midrib, but some also at right angles to the secondaries in the lower part of the leaflet; finer nervation obsolete.

Herendeen Bay; Charles H. Townsend. Type, No. 3764, U. S. N. M.

The leaflets of this species vary in size from 3·5 cm. to 5·25 cm. in length and from 1·25 cm. to 2 cm. in width. They are all broadly lanceolate in shape, with few teeth above the middle, and well marked camptodrome nervation.

These leaflets were at first supposed to belong to what has been described as *Fraxinus Herendeenensis*, n. sp., but after careful consideration they have been separated. They differ from the above species in being much narrower, lanceolate in fact, with a heart-shaped base, and the secondaries emerging at a more acute angle. The characters of the nervation and arrangement of teeth are precisely the same in both.

A larger series (the present species is represented by three and the Fraxinus by only two specimens) might show them to approach more closely than now appears to be the case.

The fossil species that they approach most closely is *Rhus Meriani*, Heer,* from the Tertiary of Switzerland, from which it is almost impossible to distinguish them. The outline, shape of the base, and nervation are the same, almost the only difference being in the teeth, and even this is but slight. Ordinarily this would by no means be considered a character of sufficient weight to separate species, but unless they agree in every particular it seems to me that the antecedent probabilities are greatly in favor of plants so widely separated geographically being different. I have therefore assumed that the plant from Herendeen Bay is very closely allied to but specifically distinct from the one from Switzerland.

Among living species *Rhus frigida* is not greatly unlike some of the leaflets of *R. typhina*, L., particularly the terminal leaflets. It is also quite like some of the leaflets of *R. glabra*, L., especially a form in the National Herbarium from Deer Park, Lower Arrow Lake, British Columbia. These are slightly heart-shaped at base and have the same general outline, but the teeth are larger and more irregularly placed than in the fossil. It would seem that this form of *R. glabra* might well be the descendent of the species that inhabited arctic countries in Eocene or Miocene time.

VITACEÆ.

VITIS CRENATA, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. VIII, fig. 6.

Port Graham; H. Furuhjelm.

VITIS ROTUNDIFOLIA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 513; Plates, Pl. LI, fig. 2; LII, fig. 3.

Admiralty Inlet; Capt. Howard, U. S. Navy.

"Leaf broadly rounded or subtriangular in outline, cordate at the base, with an acute point at the summit and at the extremity of each of the angles; intermediate portions of the margin coarsely and bluntly toothed; strongly three-nerved; tertiary nervation distinct and flexuose."—[NEWBERRY.]

CELASTRACEÆ.

ELÆODENDRON HELVETICUM, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 449, Pl. IX, fig. 4; Cret. and Tert. Fl., p. 263.

Coal Harbor, Unga Island; Dr. William H. Dall.

* Fl. Tert. Helv. III, p. 82, Pl. CXXVI, figs. 5–11.

CELASTRUS BOREALIS, Heer.

HEER, Fl. Foss. Alask., p. 37. Pl. x, fig. 4.

Port Graham; H. Furuhjelm.

ILICINEÆ.

ILEX INSIGNIS, Heer.

HEER, Fl. Foss. Alask., p. 37, Pl. x, fig. 1.

Port Graham; H. Furuhjelm.

RHAMNACEÆ.

ZIZYPHUS TOWNSENDI, new species.

Pl. IX, figs. 8, 9.

Leaf thin, elliptical-lanceolate in general outline, rounded or slightly heart-shaped at base, extending above into an acuminate apex; petiole slender, 9 mm. long; margin of leaf cut into numerous sharp, usually outward-pointing teeth, which are separated by rounded sinuses; three-ribbed from the base; midrib straight, lateral ones of the same size as the midrib, equally dividing the distance between it and the margin, and, curving around, enter the apex; finer nervation obsolete.

This fine species, which I take pleasure in naming in honor of the collector, is well shown in the two figures given. The leaves appear to have been thin but firm. They are narrowly elliptical in outline, with a rather slender petiole about 1 cm. long. In size they vary from 3·5 cm. to 5 cm. in length and from 1·5 cm. to 2·2 cm. in width. They are well characterized by the teeth and the three ribs of equal size from the base. Figure 9 differs from all the others in having a very thin fourth nerve outside of the prominent ones. Unfortunately, nothing of the ultimate nervation can be made out.

This species approaches closely to the living *Zizyphus Japonica*, Thunbg., of Japan, which differs in being less regularly elliptical and in having only weak teeth.

Among fossil species this species has many that are seemingly closely related. It is, for example, very similar to *Z. serrulatus*, Ward,* from the Fort Union Group, near the mouth of the Yellowstone River, Montana, which differs in being broader, with finer, more numerous upward-pointing teeth. Prof. Ward's species also shows a tendency to be five-nerved by the addition of slender nerves outside of the more prominent ones. *Z. cinnamomoides*, Lx.,† from the Green River Group in Colorado is also similar, but differs in being wedge-shaped at base, with fewer, sharper teeth. Some of the forms of *Z. paradisiacus*, Ung.,‡ are quite suggestive of this species, and differ in being wedge-shaped at base, with fewer, sharper teeth. *Z. hyperboreus*, Heer, § from the Miocene of Greenland, which might be expected in Alaska, is not particularly

*Types of the Laramie Flora, p. 73, Pl. XXXIII, figs. 3, 4.

† Tert. Fl., p. 277, Pl. LII, figs. 7, 8.

‡ Cf. Pilar, Foss. Fl. Susedana, p. 107, Pl. XIV, fig. 14.

§ Fl. Foss. Arct. VII, p. 130, Pl. LXVII, fig. 6.

close, as it differs in being much broader, with an acuminate apex and five nerves. *Z. Meekii*, Lesquereux,* from the Post-Laramie beds of Colorado has similar teeth, but differs in being much broader and in having five nerves.

The species is represented by about half a dozen specimens in a fairly good condition, except as relates to the finer nervation.

Herendeen Bay; Chas. H. Townsend, for whom it is named. Type, No. 3765, U. S. N. M.

PALIURUS COLOMBI, Heer.

Plate IX, fig. 2.

Herendeen Bay; Chas. H. Townsend.

The only specimen of this species is the one figured, which agrees closely with certain of the examples figured in the *Arctic Flora*.† The figure here referred to agrees almost exactly in size and nervation with our specimen. Fig. 4 of the same plate is also similar, being only much larger.

TILIACEÆ.

TILIA ALASKANA, Heer.

Heer, Fl. Foss. Alask., p. 36, Pl. x, figs. 2, 3.

Port Graham; H. Furuhjelm.

MAGNOLIACEÆ.

MAGNOLIA NORDENSKIÖLDI, Heer.

Lesquereux, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 448, Pl. x, figs. 7–9; Cret. and Tert. Fl., p. 262.

Chignik Bay; Dr. Wm. H. Dall.

PHYLLITES ARCTICA new species.

Plate IX, figs. 10, 11.

Leaf thickish, firm, approaching deltoid in general outline; deeply heart-shaped at base, 5- (possibly 9-) lobed, or 3-lobed, with the terminal larger lobe again 5- (possibly 7-) lobed; lower lobes at right angles to the midrib, above them being a central lobe which is provided with five (or seven) smaller lobes; margin all around provided with coarse blunt teeth; midrib straight, thick; secondaries, 4 pairs, the lower pair at right angles to the midrib or falling a little above or below a right angle; upper pairs at an angle of 45°, all entering the points of the lobes; lower pair of secondaries provided with about 5 pairs of tertiaries, which either enter or send branches to the teeth; upper secondaries sending out as many branches on the outside as there are teeth; nervills mainly percurrent, forming regular quadrangular areas between the secondaries and their branches; finer nervation mostly obsolete.

The collection contains numerous specimens of this very interesting plant, some of them being nearly perfect. The largest specimen appears

* Tert. Fl., p. 275, Pl. II, figs. 10–14.

† Fl. Foss. Arct. I, Pl. XIX, fig. 3.

to have been 10 cm. or more long and 6 or 7 cm. wide. The smaller examples appear to have been about 8 cm. in length and nearly or quite 8 cm. in width, as measured at the points of the lower lobes. As stated above, they are 7 to 9 lobed, or, with two prominent lower lobes and a central or terminal lobe, that is again provided with 5 or 7 smaller lobes. The leaves are deeply heart-shaped at base, with the lower lobes usually at right angles to the midrib, or in some cases falling below, but rarely rising above, a right angle. The upper secondaries, which all enter lobes, so far as can be made out, are at an angle of about 45°. They are opposite or subopposite. The margin all around is provided with coarse, rather blunt teeth, which are entered by the tertiaries or their branches.

I am unable at the present time to refer these leaves generically with any degree of satisfaction. They have, it is true, a vague resemblance to a considerable number of well-known genera, but when these are carefully investigated the fossil leaves are excluded from them for one cause or another. The leaf shown in fig. 11 is quite unlike the other more typical form, being less heart-shaped at base in having the lower lobes at an angle of about 20°, they being also more pointed and with smaller teeth; the general character, however, is the same.

Figure 11 is very much like *Acer trilobatum patens*, Heer, Fl. Tert. Helv., III, pl. CXIII, fig. II, but differs in the nervation, there being no nerve running up to and forking under the principal sinuses, a well-known character in Acer. The teeth also differ, as also does the terminal lobe.

It has been suggested that this may represent an extreme, or anomalous form of *Corylus MacQuarrii*, a very variable species well known to be common in arctic countries, especially Alaska. The base of the larger specimen (fig. 10) does have a strong likeness to some of the forms of this species, but the lobation is much more pronounced than I have ever observed and, moreover, the borders are merely toothed and not doubly serrate as are the margins of *C. MacQuarrii*.

It has been also suggested that it may belong to Vitis, and it has something of a Vitis-like appearance, but it does not appear to me to approach close enough to any species of this genus known to me. I have therefore adopted the non-committal name of Phyllites, and can only express the hope that some one may be able to more satisfactorily determine it.

Herendeen Bay; Chas. H. Townsend. Type, No. 3766, U. S. N. M.

Distribution of the fossil flora of Alaska.

Species.	Distribution in Alaska.									
	Cape Lisburn.	Cape Jaklök.	Sitka, and islands near.	Admiralty Inlet. (?)	Cook Inlet.	Port Graham, Neniltschik.	Unga Island.	Chignik.	Herendeen Bay.	Muir Glacier.
Chondrites filiciformis, Lx	×									
Chondrites Heeri, Eichw										
Equisetum globulosum, Lx										
Calamites ambiguus, Eichw		×								
Pecopteris denticulata, Heer	×									
Pteris Sitkensis, Heer			×							
Osmunda Doroschkiana, Göpp							×			
Aspidium Œrstedi, Heer	×									
Asplenium Foersteri, Deb. and Ett	×									
Asplenium Dicksonianum, Heer	×									
Pinus Staratschini, Heer	×									
Pinus sp						×				
Sequoia Langsdorfii (Brongn.)						×			×	
Sequoia spinosa, Newby					×					
Taxodium dist. miocenum, Heer			×			×			×	
Taxodium Tinajorum, Heer			×			×				
Taxodium Tinajorum var., Eichw										
Glyptostrobus Europæus, Bronginart			×			×			×	
Taxites Olriki, Heer						×				
Thuites Alaskana, Lx							×			
Ginkgo multinervis, Heer	×									
Ginkgo adiantoides, Heer			×						×	
Baiera palmata, (Unger) Heer	×									
Picea Sitchensis, Carr										×
Tsuga Mertensiana, Carr										×
Cupressinoxylon erraticum, Merck *										
Pinites pannonicus, (Ung.), Göppert							×			
Pityoxylon inæquale, Felix †										
Zamites Alaskana, Lx	×									
Podozamites latipennis, Heer	×									
Phragmites Alaskana, Heer						×				
Poacites tenue-striatus, Heer						×			×	
Carex servata, Heer						×			×	
Carex sp			×							
Sagittaria pulchella, Heer						×				
Sagittaria sp			×							
Irites Alaskana, Lx	×									
Populus latior, Al. Braun						×				
Populus glandulifera, Heer						×				
Populus balsamoides, Heer			×			×				
Populus Zaddachi, Heer						×				
Populus leucophylla, Ung						×				
Populus arctica, Heer								×		
Populus Richardsoni, Heer								×		
Salix varians, Göpp						×				
Salix macrophylla, Heer						×				
Salix Lavateri, Heer						×				
Salix Ræana, Heer					×					
Salix integra, Göpp						×				
Salix minuta, n. sp									×	
Fagus Antipofii, Heer						×				
Fagus macrophylla, Ung						×				
Fagus Feroniæ, Ung						×				
Fagus Deucalionis, Ung					×					
Castanea Ungeri, Heer			× ?			×				
Quercus pseudocastanea, Göpp						×				
Quercus Furuhjelmi, Heer						×				
Quercus pandurata, Heer						×				
Quercus Chamissoni, Heer						×				
Quercus Dallii, Lx					×					
Corylus Mac Quarrii, (Forbes) Heer			×			×	×		×	
Corylus Mac Quarrii, var. macrophylla, Heer						×				

* This species is extra-limital.

† This species comes from south of Danaáku, in southeastern Alaska.

Distribution of the fossil flora of Alaska.

Geological distribution outside of Alaska.																		Remarks.
Laramie.	Post Laramie of Colorado.	Livingston Beds.	Fort Union.	Green River Group.	Mackenzie River.	British Columbia. Laramie (L), Miocene (M).	California (auriferous gravels).	Eocene, Alum Bay, etc.	Greenland Miocene (Disco Island, Atanekerdluk).	Spitzbergen Miocene (Staratschin [S]).	Sachaline (Siberia).	Sinigalia (Italy).	Baltic Miocene.	Œningen.	Oligocene.	Miocene.	Pliocene.	
			×															
					×				×									
×	×		×	×?	×	×L	×	×	×	×	×	×	×	×	×	×		Vancouver, Naniamo.
	×	×	×		×	×LM	×		×	×	×	×	×					
									×	×								
×?	×		×		×	×LM		×	×			×	×	×	×	×	×	Birch & Bellingham bays.
					×	×L	×?		×	×								
		×	×					×	×		×							
		×?	×															
						×M					×			×	×	×	×	Mainly Miocene.
			×								×			×	×			Abundant in European Miocene.
		×	×							×		×	×	×		×	×	Mainly Upper Miocene.
	×						×		×		×		×			×		Common in European Miocene.
	×	×	×									×			×	×	×	
	×		×		×	×LM			×	×								
			×	×	×	×L	×?		×	×	×							
							×?		×	×				×	×?	×	×	
										×				×		×		
									×		×			×	×	×	×	
					×	×L	×			×			×	×				
	×						×							×		×	×	
							×		×		×					×		
									×							×		
				×?							×				×	×	×	Mainly Miocene.
						×M	×		×		×					×	×	
									×			×				×		Mainly Upper Miocene.
																×		Once found in Silesia.
						×M												
×	×	×	×		×	×L		×	×	×	×				×	×		Island of Mull.

Distribution of the fossil flora of Alaska—Continued.

Species.	Distribution in Alaska.									
	Cape Lisburn.	Cape Jaklök.	Sitka, and islands near.	Admiralty Inlet. (?)	Cook Inlet.	Port Graham, Nenïltschik.	Unga Island.	Chignik.	Herendeen Bay.	Muir Glacier.
Carpinus grandis, Ung					×	×				
Alnus Kefersteinii, (Göpp) Unger						×				
Alnus Kefersteini var., Heer						× ?				
Alnus Alaskana, Lx										
Alnus grandifolia, Newby					×					
Alnus corylifolia, Newby					×					
Alnus rubra, Bong										×
Betula prisca, Ett						×				
Betula grandifolia, Ett						×				
Betula Alaskana, Lx								×		
Myrica banksiæfolia, Ung						×				
Myrica cuspidata (Lx.), Dn							×			
Myrica præmissa (Lx.), Kn							×			
Myrica vindobonensis, (Ett.) Heer						×				
Platanus nobilis, Newby *										
Juglans acuminata, Al. Br						×				
Juglans nigella, Heer						×				
Juglans picroides, Heer						×				
Juglans Woodiana, Heer								×		
Juglans Townsendi, n. sp									×	
Ficus Alaskana, Newby				×	×					
Ficus membranacea, Newby					×					
Planera Ungeri, Ett						×				
Ulmus plurinervia, Ung						×				
Ulmus sorbifolia, Göppert					×					
Diospyros stenosepala, Heer						×				
Diospyros Alaskana, Schimper						×				
Diospyros anceps, Heer					×					
Fraxinus Herendernensis, n. sp									×	
Andromeda Grayana, Heer						×				
Vaccinium Friesii, Heer						×				
Vaccinium reticulatum, Al. Br					×					
Viburnum Nordenskiöldi, Heer						×				
Nyssa arctica ?, Heer							×			
Cornus orbifera, Heer					×					
Hedera auriculata, Heer						×				
Trapa borealis, Heer						×				
Liquidambar Eropæum, Al. Br						×				
Spiræa Andersoni, Heer						×				
Prunus variabilis, Newby					×					
Acer macropterum, Heer						×				
Acer trilobatum productum, (Al. Br.) Heer									×	
Rhus frigida, n. sp									×	
Vitis crenata, Heer						×				
Vitis rotundifolia, Newby				×						
Elæodendron Helveticum, Heer							×			
Celastrus borealis, Heer						×				
Ilix insignis, Heer						×				
Zizyphus Townsendi, n. sp									×	
Paliurus Colombi, Heer									×	
Tilia Alaskana, Heer						×				
Magnolia Nordenskiöldi, Heer								×		
Phyllites arctica, n. sp									×	

* From Topanica beds of Norton Sound (cf. Dall and Harris, Bull. U. S. Geol. Surv., No. 84, p. 246).

Distribution of the fossil flora of Alaska—Continued.

Laramie.	Post Laramie of Colorado.	Livingston Beds.	Fort Union.	Green River Group.	Mackenzie River.	British Columbia. Laramie (L), Miocene (M).	California (auriferous gravels).	Eocene, Alum Bay, etc.	Greenland Miocene (Disco Island, Atanekerdluk).	Spitzbergen Miocene (Staratschin [S]).	Sachaline (Siberia).	Sinigalia (Italy).	Baltic Miocene.	Œningen.	Oligocene.	Miocene.	Pliocene.	Remarks.
....	....	....	....	×	....	×L?M	×	....	×	×	×	....	×	....	....	×	×	Birch Bay, Orcas Island. Eocene, rare; mainly Miocene.
....	....	....	....	×	....	....	×	....	×	×	×	....	×	×	×	×	×	Few Eocene, but mainly Miocene.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	×	....	....	....	....	....	....	×	×	×	×	×	....	×	....	Few localities in Eocene, but mostly in Miocene.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	Distinctly Miocene, but not abundant.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	×	×	×	×	×	
....	....	....	....	....	....	×M	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	×	×	....	×	....	
....	....	....	×	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	×	....	....	....	×	....	×	×	....	....	....	....	....	A Miocene species very close to *J. rugosa* of United States.
....	....	....	×	....	....	....	....	....	×	....	×	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	×	....	....	....	....	....	....	....	....	....	....	....	×	....	Also Vancouver.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	×	....	....	×	×	×	....	×	×	×	×	....	×	×	Very abundant in Greenland Miocene; mainly Miocene in other distribution.
....	....	....	....	....	....	....	×	×	×	....	×	×	....	×	....	×	×	Largely Miocene in Europe.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	×	×	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....	....	Also Vancouver.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	×	....	....	....	....	....	....	....	×	....	×	....	×	....	
....	....	....	×?	....	×	....	....	....	×	×	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....	....	....	Abundant in the Greenland Miocene.
....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....	×	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	×L	....	....	....	....	×	....	....	....	....	....	....	Laramie of Canada.
....	....	....	....	....	....	....	×	....	×	....	....	×	....	×	....	×	×	Mostly Miocene.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	×	....	....	....	....	....	×	....	....	....	....	....	....	×	....	×	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	
....	....	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	×	....	×	×	....	....	×	....	×	×	×	....	....	....	....	....	....	Abundant in the Arctic Miocene.
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	
....	....	....	....	....	×	....	....	....	×	×	×	....	....	....	....	....	....	
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	

Geological distribution outside of Alaska.

EXPLANATION OF THE TABLE.

A few words as to the manner in which the table was compiled may be of assistance in understanding its scope. I have given in the first ten columns the distribution of the fossil plants in Alaska itself. These columns also show the plants that are confined in their distribution to Alaska so far as now known. The remainder of the table is devoted to those having a distribution outside of Alaska, with the exception of those from Cape Lisburn. As those belong clearly to a much older horizon (Neocomian) about which there is little or no doubt, it has been thought unnecessary to increase the size of the table so as to show them.*

The next eight columns are devoted to the distribution of the Tertiary plants of Alaska in the United States and British Columbia. I have then selected a number of typical localities in different parts of the world at which places an abundant upper Tertiary flora is developed, such as Disco Island and Atanekerdluk, Greenland, Spitzbergen, Sachalin, Sinigalia, Œningen, etc. The last three columns are reserved for Oligocene, Miocene, and Pliocene, when the species under discussion is not found in any of the selected typical localities, yet occurs in these horizons in other localities.

DISCUSSION OF THE TABLE.

The fossil flora of Alaska as presented in this paper embraces 115 forms. Of this number 1 is regarded as extra-limital and 3 are interglacial, being found also living about the Muir Glacier. Of the 111 forms remaining no less than 46 are peculiar to Alaska, leaving 64 forms having an outside distribution. On removing the 9 species found at Cape Lisburn about which, as pointed out above, there is little question of age, we have remaining only 55 species or a little less than 50 per cent upon which to depend for the determination of the bearing of the plants on the question of age.

An examination of the table yields the following numerical results: The Laramie has 3 species, of which 1 is doubtful; the Post Laramie beds of Colorado 10 species; the Livingston beds of Montana 6 species; the Fort Union beds 16 species, of which 1 is doubtful; the Green River Group 9 species, of which 3 are in doubt; the Mackenzie River 11 species; British Columbia has 7 species in the Miocene and 4 in the Laramie, with 2 common to both; California, represented by the auriferous gravels and allied formations, has 17 species, of which 3 are in doubt; the Eocene (Alum Bay, etc.) 6 species; the Greenland Miocene, as represented at Disco Island, Atanekerdluk, etc., has 29 species; the Miocene of Spitzbergen 20 species; the island of Sachalin (Siberia) 23 species; Sinigalia (Italy) 12 species; the so-called Baltic Miocene

*The Cape Lisburn plants will be treated by Prof. Lester F. Ward in his forthcoming paper on the correlation of the fossil plants of the Lower Cretaceous.

13 species; Œningen 20 species; Oligocene 11 species; Miocene 33 species; Pliocene 15 species.

By combining a number of the above localities which may be legitimately taken together we have still more impressive results. Thus by the combining of the Post Laramie beds of Colorado with the Livingston beds of Montana, we have 13 species common to Alaska. The union of the Mackenzie River and Fort Union deposits gives 21 species common to Alaska, while Greenland, Spitzbergen, and Sachalin have no less than 39 species out of the 55 species from Alaska. This last result shows, if we are to place any dependence in fossil plants, that the floras of Alaska, Greenland, Spitzbergen, and the island of Sachalin are so closely related as to lead to the unavoidable conclusion that they grew under similar conditions and were synchronously deposited. The localities enumerated show that the circumpolar flora at that time was practically similar and continuous.

The coal-bearing beds of southeastern Alaska, to which Dall has given the name of the Kenai group, are perhaps best exhibited on the shores of Kachekmak Bay, Kenai Peninsula, and Cook Inlet. They appear, however, to be widely spread over British Columbia and over the coast of Alaska and its neighboring islands. According to Dall* the sequence of the rocks when undisturbed appears to be in descending order, as follows:

1. Soil and Pleistocene beds.
2. Brown Miocene sandstone, with marine shells, cetacean bones, and water-worn, teredo-bored fossil wood. (Astoria group, Nulato sandstones, Crepidula bed.)
3. Beds of conglomerate, brown and iron-stained, alternating with gravelly and sandy layers, the finer beds containing fossil leaves of Sequoia and other vegetable remains. (Kenai group, Unga beds.)
4. Bluish sandy slates and shales with a rich Miocene plant flora, interstratified with beds of indurated gravel, fossil wood, and lignitic coal. (Kenai group.)
5. Metamorphic quartzites and slaty rocks, illustrating the geologic series probably from the Jurassic to the Upper Cretaceous, with perhaps part of the Lower Eocene. (Chico-Tejon.)
6. Granite and syenite in massive beds, usually without mica and apparently in most instances forming the "backbone" of the mountain ridges or islands, but occasionally occurring in intrusive masses. (Shumagin granite.)

The geological age of these coal-bearing rocks, from which most of the plants enumerated in this paper came, has usually been regarded as Miocene. Heer, who worked up the first considerable collection of plants, referred them unhesitatingly to this horizon, and regarded them as the equivalent of the Miocene beds of Greenland, Spitzbergen, the Braunkohl of East Prussia, and the lower Molasse of Switzerland. Lesquereux and at first Newberry do not appear to have seriously questioned their Miocene age. Of the 73 species enumerated by Lesquereux in his latest publication on Alaskan plants, 21 are found in Greenland and Spitzbergen and 31 in the Miocene of other parts of the world. These considerations show, as already pointed out under

* Bull. U. S. Geol. Survey, No. 85, p. 233.

the discussion of the table, that the fossil flora of Alaska is inseparably connected with that of the Disco Island and Atanekerdluk beds of Greenland and the so-called Arctic Miocene of Spitzbergen and Sachalin. Whatever is decided concerning them must apply with equal force to Alaska.

Mr. J. Starkie Gardner appears to have been the first to question the Miocene age of the Greenland beds,* or rather of the Arctic floras in general. The sequence of British Eocene floras is almost unbroken, and in studying them and their relations to the Miocene flora he was lead to important conclusions. He says:

There is no great break in passing from one to the other (Eocene to Miocene) when we compare them over many latitudes, and but little change beyond that brought about by altered temperature or migration. But if Tertiary floras of different ages are met with in one area, great changes on the contrary are seen, and these are mainly due to progressive modifications in climate and to altered distribution of land. Impreceptibly, too, the tropical members of the flora disappeared; that is to say, they migrated, for most of their types, I think, actually survive at the present day, many but slightly altered. Then the subtropical members decreased, and the temperate forms, never quite absent even in the Middle Eocenes, preponderated. As decreasing temperature drove the tropical forms south, the more northern must have pressed more closely upon them. The Northern Eocene, or the temperate floras of that period, must have pushed, from their home in the far north, more and more south as climates chilled, and at last, in the Miocene time, occupied our latitudes. The relative preponderence of these elements, I believe, will assist in determining the age of Tertiary deposits in Europe more than any minute comparisons of species. Thus it is useless to seek in the Arctic regions for Eocene floras, as we know them in our latitudes, for during the Tertiary period the climatic conditions of the earth did not permit their growth there. Arctic floras of temperate, and therefore Miocene, aspect are in all probability of Eocene age, and what has been recognized as a newer or Miocene facies is due to their having been first studied in Europe in latitudes which only became fitted for them in Miocene times.

This change of view as to the age of the so-called Arctic Miocene, as proposed by Gardner, has already received considerable confirmation from American paleobotanists, and while it can hardly be regarded as settled, it may be accepted as extremely probable.

Dr. J. S. Newberry, in one of his latest publications, said:†

I called the Fort Union Group Miocene because I identified it with the plant-bearing beds of Mackenzie River, Disco Island, Greenland, etc., of which the flora had been studied by Prof. Oswald Heer and was by him called Miocene. This flora, to which I shall again refer, has since been shown by Mr. J. Starkie Gardner to be Eocene. The Fort Union flora has many species in common with the Eocene beds of the Island of Mull, Bourenemouth, etc., and holds undoubtedly the same position.

On this same point Sir William Dawson says:‡

I have, also, while writing out the above notes for publication, received the paper of the same author (Gardner) on the Eocene beds of Ardtun, in Mull, and am fully confirmed thereby in the opinion derived from the papers of the Duke of Argyll and the late Prof. E. Forbes that the Mull beds very closely correspond in age with the

* British Eocene Flora, Part I, 1879, p. 8.

† Trans. N. Y. Acad. Sci. vol. IX, p. 1 of reprint.

‡ Trans. Roy. Soc. Canada, 1887, p. 36.

Laramie. The *Filicites Hebridica* of Forbes is our *Onoclea sensibilis.* The species of *Ginkgo, Taxus, Sequoia,* and *Glyptostrobus* correspond, and we have now probably found a *Podocarpus,* as noted above. The *Platanites Hebridica* is very near to our great *Platanus nobilis.* *Corylus MacQuarrii* is common to both formations, as well as *Populus arctica* and *P. Richardsoni,* while many of the other exogens are generically the same, and very closely allied. These Ardtun beds are regarded by Mr. Gardner as Lower Eocene, or a little older than the Gelinden series of Saporta, and nearly of the same age with the so-called Miocene of Atanekerdluk, in Greenland. Dr. G. Dawson and the writer have, ever since 1875, maintained the Lower Eocene age of our Laramie, and of the Fort Union group of the Northwestern United States, and the identity of their flora with that of Mackenzie River and the upper beds of Greenland, and it is very satisfactory to find that Mr. Gardner has independently arrived at similar conclusions with respect to the Eocene of Great Britain.

Dr. Dall is rather more cautious in adopting the Eocene age of these beds. He says:*

I have already pointed out the probability that, if Miocene at all, the leaf beds of Greenland referred to would be synchronous with that geological epoch during which the old Miocene warm-water invertebrate fauna of the Atlantic coast penetrated as far north as New Jersey. Since that time it is highly improbable that any temperate conditions, such as the flora would indicate for the Atane period, have obtained in the latitude of Greenland. In other words, the Greenland beds are not later than the old Miocene, though this does not preclude a reference of them to an older horizon than the Miocene, for during the Eocene also the conditions in the extreme north might have been favorable to such a flora.

In Alaska, at Cooks Inlet, at Unga Island, at Sitka, and at Nulato, in the Yukon Valley, we find the leaf beds of the Kenai group immediately and conformably overlain by marine beds containing fossil shells, which are common to the Miocene of Astoria, Oregon, and to middle and southern California.

It is then certain that the Kenai leaf beds immediately preceded and their deposition terminated with the depression (probably moderate in vertical range), which enabled the marine Miocene fauna to spread over part of the antecedently dry land. Further researches along the Alaskan coast will doubtless enable us to determine whether the leaf beds themselves are underlain by marine Eocene beds or not. We know that the Aucella beds underlie the Kenai series, but whether there are any beds representing the marine phase of the Eocene between them is yet uncertain, though very probable.

What may be considered as reasonably certain is that the period during which in the Arctic regions the last temperate flora flourished was in a general way the same for all parts of the Arctic. It would seem highly improbable that a temperate climate should exist in the Spitzbergen and not at the same time in Greenland and Alaska, or vice versa. If Alaska was covered by the sea at this time, we should find a temperate marine fauna; if it was dry land, a temperate flora; and so with the other Arctic localities; and these indications should, it would seem, represent an identical and synchronic phase of geological history in the Arctic regions.

The distribution and character of this group have been somewhat fully discussed because, up to very recently, authorities were practically unanimous in referring it to the Miocene, a view which can yet be said to be definitely refuted. But when we consider how the Eocene Astoria bed is immediately and conformably overlain at Astoria by shales and sandstones, and that the latter conformably and immediately in like manner overlies the Kenai group, it must be conceded that the view that the latter is probably of Eocene age does not appear unreasonable.

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* Bull. U. S. Geol. Survey, No. 85, p. 251.

Following out the argument suggested by Newberry and Dawson, that is, the relation existing between the plants of Alaska and Mackenzie River, and these in turn with the Canadian Laramie and the Fort Union group, we have important confirmatory evidence. The flora of the Mackenzie River beds, as worked out by Heer,* Schrœter,† and Dawson,‡ now numbers 30 species, and of these no less than 12, or 40 per cent, are found in Alaska. The 12 species common to Alaska are not rare or poorly defined in the Alaskan flora, but are in the main well marked and readily determinable forms, most of which are very abundant in individuals, as for example *Sequoia Langsdorfii*, *Taxodium distichum miocenum*, *Glyptostrobus Europæus* or *Ungeri*, *Corylus MacQuarrii*, *Populus arctica*, etc. A single species, *Pteris Sitkensis*, is confined to these two localities, and a number of other species, though known by different names, are closely allied, if not identical. There can be, therefore, little doubt as to the close relationship between the Alaskan and the Mackenzie River deposits.

The Mackenzie River flora, as already suggested, is in like manner closely related with the Canadian Upper Laramie, or Fort Union group, as it is called in the United States, about 30 per cent of the Mackenzie species being common to the two.

On turning to the table we find that 16 of the 55 Alaskan species are found in the Fort Union of the United States. By combining the species common to the Mackenzie River, Canadian Upper Laramie, and Fort Union, we have 22 or 23 of these species also found in the Alaskan beds.

Without going further into the subject, which indeed the present state of our knowledge will hardly warrant, it is safe to say with Sir William Dawson that "There can scarcely be any doubt that the flora of the Upper Laramie, of the Atanekerdluk series in Greenland, and of the Spitzbergen and Alaskan Tertiaries corresponds with the Eocene of Europe, and is also identical with Fort Union flora of the Missouri region, formerly regarded as Miocene."

Explanation of Plate IX.

Fig. 1. Salix minuta, n. sp..

Fig. 2. Paliurus Colombi, Heer..

Fig. 3. Acer trilobatum productum, (Al. Br.) Heer........................

Fig. 4. Corylus MacQuarrii, (Forbes) Heer........................

Fig. 5. Juglans Townsendi, n. sp..

Fig. 6. Rhus frigida, n. sp..

Fig. 7. Fraxinus Herendeenensis, n. sp..

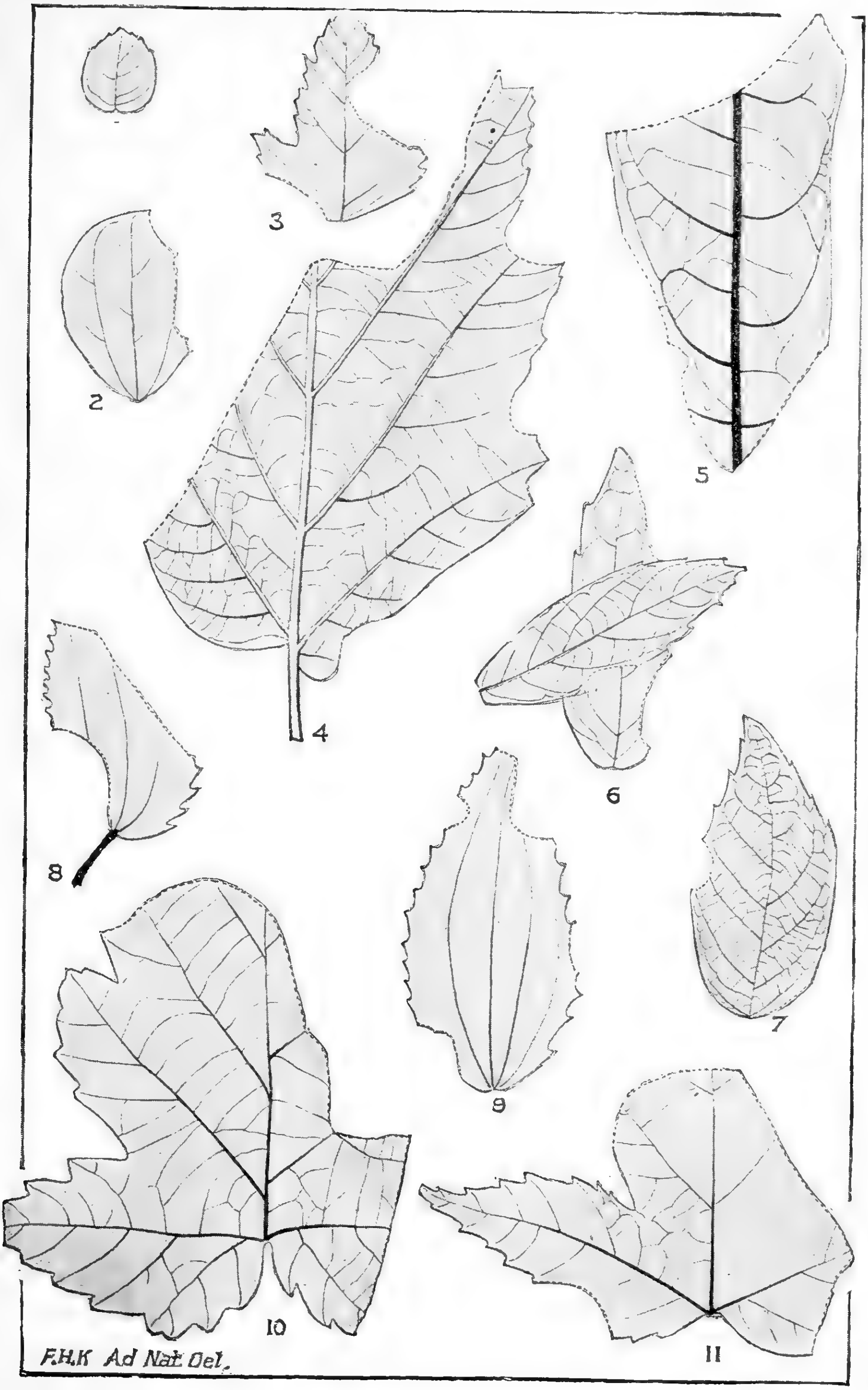
Figs. 8, 9. Zizyphus Townsendi, n. sp..

Figs. 10, 11. Phyllites arctica, n. sp..

* Fl. Foss. Arct. Vol. vi. 1 Abth., 3d Nr. Beiträge zur Miocene Fl. v. Nord-Canada.

† *Op. cit.* Vol. vi. 1 Abth., 4th Nr. Untersuchung ü. foss. Hölzer d. Arct. zone.

‡ Trans. Roy. Soc. Canada. 1889. Fossil plants from Mackenzie and Bow rivers.



FOSSIL PLANTS FROM HERENDEEN BAY, ALASKA.

DIAGNOSES OF NEW NORTH AMERICAN MAMMALS.

By Frederick W. True,
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In connection with certain studies of North American mammals which I have recently undertaken, I find it desirable to separate out a few forms under new names. A mole from Fort Klamath, Oregon, presents certain cranial and dental differences from described species which seem to me worthy of recognition, and I regard it necessary to place Brewer's mole in a new genus. I desire in addition to publish diagnoses of an undescribed race of Abert's squirrel, a new lemming, and a lemming-like mouse, representing a new genus.

SCIURUS ABERTI CONCOLOR, new subspecies.

Similar to *S. aberti*, but with no rufous area on the back, all the upper surfaces being gray throughout. Tail alike on both sides; the hair annulated with gray and white proximally, with a rather broad subterminal black ring and pure white tips. Ears gray within; externally gray and rufous, as in the typical form of *S. aberti;* furnished with long terminal pencils, which are black, more or less mixed with gray and rufous. Under surfaces of body and limbs pure white; the hairs, however, gray in the basil third, except on the under side of the front legs, where they are white to the base. Backs of feet gray; toes white.

Dimensions (from the dry skin; type).—Head and body, 280 mm.; tail vertebræ, 215 mm.; ear from the occiput (without pencil), 22 mm.; hind foot (without claw), 61 mm.

Type.—No. $\frac{21423}{36281}$, U. S. N. M, female, Loveland, Larimer County, Colo. Collected by William S. Smith.

A male from the same locality is melanistic. All the melanistic specimens of Abert's squirrel in the study collection of the National Museum are from Colorado.

The variety above described shows a remarkable resemblance to *Sciurus fossor*, but the latter is without ear-tufts.

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[Advance sheets of this paper were published April 26, 1894.]

SCAPANUS DILATUS, new species.

Exterior unknown.

Dental formula.—I. $\frac{3}{3}$, C. $\frac{1}{1}$, PM. $\frac{3}{4}$, M. $\frac{3}{3}$. Penultimate premolar with a posterior cusp.

Size of skull moderate. Maxillary above the first molar broad (equal in breadth to the interparietal bone), with a strong ridge separated from the root of the zygoma by an emargination. Antero-external angles of the interparietal not rounded off. Angular process of the mandible narrow, strongly uncinate.

Dimensions of skull (type).—Greatest length, 34 mm.; basilar length (Hensel), 28.5 mm.; greatest breadth across maxillæ, 10.5; greatest zygomatic breadth, 14 mm.; length of tooth-row, 15 mm.; length of parietals, 11.1 mm.; breadth of interparietal, 10.5 mm.

Type.—No 1286, Merriam Collection, Fort Klamath, Oreg. (Skeleton.) Collected by Capt. C. E. Bendire.

PARASCALOPS, new genus.

Premolars, $\frac{4}{4}$. Molars with a trilobed internal basal projection extending across the bases of both externals cusps. Tympanic bullæ incomplete and annular. Pelvis with no osseous bridges opposite or posterior to the acetabulum, connecting the sacral vertebræ with the pelvis. Extremity of the spinous processes of the sacral vertebræ connected by a continuous band of bone, but the intervals between the spines themselves not filled in with bone.

Tail hairy. General color black.

Type.—*Scalops breweri*, Bachman.

MYODES NIGRIPES, new species.

Upper surfaces nearly uniform cinnamon-gray, without bands or spots. Sides, including the lower part of the cheeks and neck, clear tawny brown. Under surfaces paler tawny, which tint is gradually merged into the stronger color of the sides. Nose black. Fore feet black above, tawny below. Hind feet black both above and below. Tail bicolored, black above, pale tawny below.

Dimensions (from dry skin; type).—Head and body, 130 mm.; tail vertebræ, 13 mm.; hind foot (without claw), 17.5 mm.

Type.—No. 59152, U. S. N. M., male, St. George's Island, Alaska. Collected by Charles H. Townsend, August 18.

MICTOMYS, new genus.

General appearance that of *Synaptomys*. Ears moderate. Tail short, hairy. Thumb with a strap-shaped nail, as in *Myodes*. Mammæ, 4 pairs.

Skull similar to that of *Synaptomys*. Incisors obliquely beveled and broadly grooved on the bevel. Molars rootless. Upper molars as in

Synaptomys. Lower molars resembling those of *Phenacomys* and *Synaptomys*, but with the external border of enamel merely crenulate, with no external reëntrant angles, or triangles of dentine, except in the middle of the last tooth, where there is a short indentation.

Type.—M. innuitus, as below.

MICTOMYS INNUITUS, new species.

Size moderate. Ears well developed, rounded, about as long as the fur immediately in front of their base. Five tubercles on the hind feet; soles hairy. Claws well developed, compressed. Upper surfaces grayish brown, as in *Synaptomys.* Under surfaces gray. Face pale brown. Lips, end of nose, and chin, white. Feet pale brown. Tail bicolored, pale brown above, white below. Ears clothed with rather long and sparse brown hairs.

Dimensions (from alcoholic specimen; type).—Head and body, 88 mm.; tail vertebræ, 15 mm.; terminal pencil, 5 mm.; ear, from base of orifice, 9.5 mm.; hind foot (without claw), 15 mm.

Type.—No. 14838, U. S. N. M., nursing female, Fort Chimo, Ungava, Labrador. Collected by L. M. Turner; spring, 1884.

DESCRIPTIONS OF NEW SPECIES OF STARFISHES AND OPHIURANS, WITH A REVISION OF CERTAIN SPECIES FORMERLY DESCRIBED; MOSTLY FROM THE COLLECTIONS MADE BY THE UNITED STATES COMMISSION OF FISH AND FISHERIES.

By A. E. VERRILL.

IN THE following list the serial arrangement adopted by Sladen in the Voyage of the Challenger has been followed pretty closely, partly as a matter of convenience, but also because it probably represents, in most cases, the real affinities of the genera more nearly than any other published classification. I am not prepared, however, to adopt all the families and subfamilies proposed by him.

ASTERIOIDEA.

Family ARCHASTERIDÆ, (Viguier, 1878) emended, Sladen.

BENTHOPECTININÆ, new subfamily.

Disk small; rays elongated, angular. Marginal plates large, spiniferous; an odd one, above and below, in the interradial angles. Dorsal surface covered with simple flattened plates usually bearing few spines; no paxillæ. Papulæ simple, arranged on the baso-median part of the rays and on the adjacent parts of the disk. Adambulacral plates, with a salient inner angle bearing spines. Pectinate pedicellariæ are sometimes present. No superambulacral plates. Dorsal pore very evident.

BENTHOPECTEN SPINOSUS, Verrill.

Benthopecten spinosus, VERRILL, American Journal of Science, XXVIII, p. 218, 1884.

Pararchaster semisquamatus, var. *occidentalis,* SLADEN, Voyage of the Challenger, XXX, p. 10, 1889.

Pararchaster armatus, SLADEN, *op. cit.*, p. 19, pl. 1, figs 5, 6; pl. 4, figs 5, 6, 1889.

A comparison of a large series of this species, of various sizes from those that are 15 mm. up to large ones 260 mm. in diameter, shows that

the two forms described by Sladen from off the American coast are probably both identical with that described by me.

This species varies considerably in several details of its structure, according to its age. None of Sladen's specimens were full grown (largest size given is 74 mm. in diameter). Moreover there is often considerable variation in specimens of the same size and from the same locality, in the size of the disk, number, size, and arrangement of the spires on the marginal plates, etc. Some few examples have the disk at least one-third broader than others having the same length of rays, and such specimens naturally have large inferior interradial areas, with the plates more numerous than usual, as many as twenty to twenty-five being present in some cases. The papulæ often extend out on the rays, in large examples, as far as the fifth pair of marginal plates; they cease sooner in the median line than to either side of it. They are often present on the central area of the disk, among the large primary spines. The actinal and adambulacral spines on the largest specimens are more numerous and longer than Sladen's descriptions indicate, but the half-grown specimens agree well with his examples, in most respects.

The pectinate pedicellariæ described by Sladen as characteristic of *P. armatus* are commonly lacking entirely on our specimens, or exist only in very small numbers. The dorsal plates of the rays are rounded and ovate, unequal, and most commonly isolated in the integument. They usually bear only a single, small, slender, acute spine, rarely two. The large disk-spines are variable in number and length, but they are always restricted to the central area of the disk, and the largest are borne on the primary plates. The large single spines on the odd interradial marginal plates are usually long, tapered, acute, and distinctly larger and longer than those on the disk. The lower marginal plates generally bear, in large specimens, one large, primary, acute spine, and one or two, rarely three, secondary ones below it, besides several small, slender, divergent, rough spinelets scattered around their bases. The adambulacral plates, in such specimens, generally have two or three long, slender, rough spines on the actinal side, besides several small, slender, spinelets on the outer margin; the angular and salient inner margin usually bears about seven slender spines in a V-shaped group.

I have seen a few regular four-rayed specimens, and also one peculiar monstrosity, in which a small supplementary ray buds out from the side of the regular ray, near the base. This species occurred at many stations in 721 to 2021 fathoms.

PONTASTERINÆ, new subfamily.

Rays long; disk of moderate size. Papulæ arranged in a group at the base of each ray, and sometimes on the disk. Dorsal surface covered with spinopaxillæ and protopaxillæ. Marginal plates all paired, usually spiniferous. Pedicellariæ often present, mostly compound, two

to four-valved, or pectinate. Superambulacral plates are lacking. Fascioles rudimentary or lacking.

PONTASTER HEBITUS, Sladen.

Pontaster hebitus, SLADEN, Voyage of the Challenger, XXX, p. 33, pl. 8, figs. 1, 2; pl. 12, figs. 1, 2, 1889.
Archaster tenuispinus, VERRILL, Proc. U. S. Nat. Mus., II, p. 203, 1879; Rep. Com'r of Fish and Fisheries, XI [for 1883], p. 543, pl. 13, fig. 38, 1885 (probably not of Düben and Koren).

In my former papers I considered this species identical with *P. tenuispinus* of northern Europe, but Mr. Sladen describes it as distinct. The two forms are certainly very closely related, but, as I have not had the European species for comparison, I follow his decision.

Our specimens, however, in many cases, approach nearer to the European form than does the type of *P. hebitus*, as described by Sladen; for in our series the marginal and adambulacral spines are often mostly long and acute (not truncate as described) and the disk is often as large as in *P. tenuispinus*. But the pedicellariæ, characteristic of the latter, seem to be absent in the American form.

Most of the specimens have been taken by the Gloucester, Mass., fishermen from the fishing banks off Nova Scotia and Newfoundland, in 128 to 250 fathoms.

PONTASTER FORCIPATUS, Sladen.

Pontaster forcipatus, SLADEN, Voyage of the Challenger, XXX, p. 43, pl. 8, figs. 3, 4; pl. 12, figs. 3, 4, 1889.
Archaster tenuispinus, VERRILL (part), *op. cit.*, XI, p, 543, 1885 (not Dub. and Koren).

This species was also included by me, in some of my former articles, under the name of *Archaster tenuispinus*, of which it was at first supposed to be a variety.

It is easily distinguished from *P. hebitus* by the presence of only a single large spine on the actinal surface of the adambulacral plates. The peculiar four-valved to six-valved pedicellariæ are usually present in considerable numbers on the ventral surfaces; sometimes, on the distal part of the ray, pedicelled, three-valved ones occur. The central spine of the dorsal plates is larger and longer than in *P. hebitus*, and so are the marginal spines of both series. The papular areas are smaller, more rounded, and have but few pores. This species was taken at many stations, in depths ranging from 956 to 1,396 fathoms.

PONTASTER SEPITUS, Verrill.

Archaster sepitus, VERRILL, Amer. Journ. Science, XXIX, p. 151, Feb., 1885.

This species is a true *Pontaster*. It is very distinct from both the preceding, and is easily distinguished by the relatively larger, broader, thicker, and more convex marginal plates, with deeper sutures between them. The marginal spines are more conical, with enlarged bases, but not so long as in the last species. The dorsal spinopaxillæ and para-

paxillæ are larger than in either of our other species; many have a slender central spine. The papular areas are small, rounded, and have few large pores. The genital openings are far apart, about opposite the distal third of the first pair of marginal plates and close to them. The upper marginal plates of the first pair are rounded and smaller than those that follow them, but the corresponding lower ones are distinctly larger and more swollen on the under side than those that succeed them. There is only one large stout spine on the actinal side of the adambulacral plates.

This occurred in 368 to 858 fathoms.

Subfamily PLUTONASTERINÆ, Sladen.

DYTASTER GRANDIS, Verrill.

Archaster grandis, VERRILL, Amer. Journ. Science, XXVIII, p. 218, 1884.
Dytaster madreporifer, SLADEN, *op. cit.*, p. 70, pl. 3, figs. 3, 4; pl. 32, figs. 5, 6, 1889.

This species is clearly identical with that so well described and figured by Sladen, but his specimens were not full grown.

Our large series includes all sizes from the young 10 mm. in diameter up to large ones 260 mm. in diameter. The very young specimens are widely different from the adults, but specimens 50 mm. in diameter have the general characters of the adults.

This species, and probably others of the genus, have well-developed superambulacral plates, which would, perhaps, indicate special affinities with the Astropectinidæ were not such plates present in several other widely different genera.

A few regular four-rayed examples have been taken. This species was taken in 384 to 2,620 fathoms.

PLUTONASTER AGASSIZII, Verrill.

Archaster agassizii, VERRILL, Amer. Journ. Science, XX, p. 403, 1880.
Plutonaster rigidus, SLADEN, *op. cit.*, p. 91, pl. 14, figs. 3, 4; pl. 15, figs. 3, 4, 1889; also var. *semiarmata*, *op. cit.*, p. 94.
Plutonaster bifrons (part), SLADEN, *op. cit.*, p. 88, 1889 (very young example).

This species is closely allied to *P. bifrons* of Europe and *P. intermedius* (Perrier sp.)* of the West Indian region. It varies greatly in respect to the armature of the marginal plates. In one large series there are among the adult specimens all gradations from those having no marginal spines whatever to those that have a large spine on nearly every marginal plate of both series. Therefore it is useless to recognize varieties based on this character, like the variety *semiarmata* of Sladen.

*Nouvelles Archives du Museum d'Hist. Nat., Ser. 2, vol. 6, p. 251, pl. VII, figs. 1, 2; pl. IV, fig. 4, 1884.

This species has distinct though short superambulacral plates at the base of the rays and within the margin of the disk, but they are lacking in the distal part of the rays. The papulæ are confined to a star-shaped area, occupying the center of the disk and the basal median part of the rays.

A few regular six-rayed specimens were taken by the *Albatross*.

The young, when very small, differ greatly from the adults in structure and appearance.

This is one of the most abundant of the deep-sea starfishes taken by the U. S. Fish Commission, as well as one of the most beautiful.

It occurred at many stations in 182 to 1,594 fathoms.

This and the other species of *Plutonaster* would be included in the genus *Goniopecten*, as defined by Perrier, but as his first species (*G. demonstrans*) appears to be a distinct generic type, perhaps allied more nearly to *Psilaster*, and apparently belonging to the Astropectinidæ, his name should be restricted to that type.

Subfamily PSEUDARCHASTERINÆ, Sladen.

PSEUDARCHASTER INTERMEDIUS, Sladen.

Pseudarchaster intermedius, SLADEN, Voyage of the Challenger, XXX, p. 115, pl. 19, figs. 3, 4; pl. 42, figs. 5, 6, 1889.

Archaster parelii, VERRILL, Amer. Journ. Science, VII, p. 500, 1874 (not Düben and Koren); XXIII, p. 140, 1882; Rep. U. S. Com'r Fish and Fisheries, XI, p. 543, pl. 13, fig. 37, 1885 (var. with narrow rays).

According to Sladen, this is distinct from the allied European *parelii*, with which I formerly identified it, but without a direct comparison of specimens.

Our numerous specimens show considerable variation, especially in the size of the marginal plates as compared with the breadth of the dorsal area of the rays. In some examples the upper marginal plates are so broad that the dorsal area is much reduced in breadth. In others the marginal plates are comparatively narrow, while the dorsal area is wider.

These differences are not correlated with any others of importance, so that they can hardly be taken as characteristic of permanent varieties.

The papulæ are confined to the central part of the disk and baso-median part of the rays.

Distinct fascioles are present in our specimens between the plates next to the adambulacral series, as in *P. discus*, but Sladen states that they are wanting in his examples. Moreover, in all our specimens there is a median row of several enlarged spinules decidedly larger than the rest, on each of the inferior marginal plates, which was not the case in Sladen's specimens. Similar enlarged spinules occur on most of the actinal interradial plates. In consequence of these differences our examples approach much nearer to *P. discus* Sladen, from the west coast

of S. America, and to *P. tessellatus*, from off Cape of Good Hope, than is indicated by Sladen's descriptions.

It ranges from 110 to 1,608 fathoms, off our coast.

PSEUDARCHASTER CONCINNUS, new species.

A large, regularly stellate, five-rayed species, having a broad flat disk and a rather thick margin with the interradial border regularly incurved. Rays broad at the base tapering regularly to slender subacute tips. Lesser to greater radius as 1 to 3.5.

Abactinal area covered with regular hexagonal and rounded paxiliform groups, those in the center of the disk and along the middle of the rays, decidedly larger than the rest, slightly convex, with a central group of from 20 to 30 obtuse, slightly elevated granules or papillæ and a marginal series of from 20 to 30 smaller and more slender divergent papillæ.

Upper marginal plates are nearly vertical and slightly convex and encroach but little on the disk. They are much higher than long on the margin of the disk, and are covered with rather large, rounded granules. Lower marginal plates nearly horizontal, confined largely to the actinal surface, and thickly covered with acute, imbricated spines, those on the middle largest.

Actinal interradial areas large, occupied by closely united plates, of which the outlines are indistinct. Each plate bears one to three or more acute fusiform spines in the middle, and a marginal series of much smaller and more slender spines of similar form or more clavate. The adambulacral plates project inward nearly half across the furrow, leaving deep angular notches between them. The furrow series of adambulacral spines arise from the margins of the projecting portion of the plate, and each angular group contains eight to ten rather slender, moderately long, obtuse spines, of which the middle ones are a little the longest.

The largest specimen, from station 2706, had, when dried, the radius of the disk, 34 mm.; of the rays, 105 to 110 mm.; breadth of rays at base, 40 mm.; height or thickness of interradial margin, 12 mm.; height of largest superior, marginal, interradial plates, 11 mm.; their length, 2.5 to 3 mm.; diameter of the large paxillæ of the median radial series, 3 mm.; diameter of madreporic plate, 2 mm.

The central area of the disk is occupied by rather close set, roundish parapaxillæ. The anal pore is small but distinct, nearly central. The madreporic plate is small, nearer to the center than the margin (distance from the center, 12 mm. in the largest specimen). The ten radial and interradial primary plates scarcely differ in size and form from the adjacent plates. Three to five rows of large hexagonal paxillæ extend along the middle radial areas of the disk and bases of the arms, becoming smaller and less regular beyond the middle of the arm. On the disk these are bordered on each side by several rows of

similar paxilliform groups, which become smaller as they approach the interradial margin; owing to this arrangement the largest and most regular paxillæ form a star-shaped area, in which the papulæ are situated. The larger hexagonal paxillæ often bear 50 to 60 granules and papillæ; nearly the whole of the round and slightly convex summit is occupied by the central group of somewhat elevated, blunt granules, which are not closely crowded; the extreme margin is bordered by about the same number of smaller, longer, and more slender papillæ, which spread outward, so that those of adjacent paxillæ are nearly or quite in contact, except at the angles, where the papulæ are situated. These paxilliform groups are borne upon round, convex, columnar or somewhat clavate elevations of the plates. In the triangular interradial areas and along each side of the rays the plates are smaller and closely united, without papulary pores, and their central elevations become smaller and lower as they approach the margin, those near the marginal plate becoming oblong or elliptical and closely crowded together side by side in rows perpendicular to the marginal plates; usually two of these rows start inward from each marginal plate along the sides of the arms, but toward the center of the interradial area three rows often correspond to a single plate. Similar plates occupy the entire breadth of the dorsal area of the arms beyond the middle, where no papulary pores exist, but those of the median row can be distinguished even to the tip of the arm by their larger size and broader form.

The papulary pores are small, and about six surround each plate; they are wanting in the triangular interradial areas and along the sides and on the distal half of the rays. In each dorsal interradial area there are two larger pores, which are usually quite easily distinguished in dry specimens even without removing the granules. They are situated opposite each of the second pair of plates, counting from the interradial angles, and are at a considerable distance from the marginal plates; they appear to be the genital pores, which are larger and much wider apart than usual.

Our largest specimen has thirty-nine upper marginal plates on each radial side and a corresponding number of inferior marginal plates; the former stand nearly vertically and project but little upon the disk, but along the sides of the rays they advance more and more on the abactinal surface. At first their height is more than three times the length, but the length rapidly becomes greater and the height less, until on the distal half of the ray the form is squarish, with the height only a little greater than the breadth. All the upper plates are covered with rather large, rounded, cylindrical, capitate, unequal granules; the sutures are bordered by a marginal series of small, slightly elongated, clavate papillæ, forming distinct fascioles continuous with those between the lower marginal plates; the granules on the upper part of the plates are but little elevated, but toward the lower end become larger and

more elevated, until close to the lower end some of those on the middle of the plate are relatively larger, higher than broad, with distinctly enlarged or capitate, rounded ends. The lower marginal plates correspond to the upper ones in number and nearly in breadth, but the sutures along the sides of the rays are not always closely coincident.

The plates occupying the interradial regions are nearly horizontal and somewhat wedge-shaped, with the breadth radially more than three times the transverse length, but along the sides of the rays they rise upward more, and the length increases in proportion to the height, as in the case of the upper ones. Their outer surface is covered with rather stout, mostly fusiform, very acute spinules, equal in size; the larger ones in length are about equal to one-half the lesser diameter of the plate, and form three or four irregular radial rows, with the smaller and more slender ones interspersed. All the spines are loosely appressed to the plates and directed upward and outward in the preserved specimens, but they are not closely crowded and are scarcely imbricated. In smaller specimens, about half grown (radius, 60 mm.), the spines on the lower marginal plates are mostly not fusiform, but slender and regularly tapered, and they form but three regular rows on the middle of the plates, while the smaller and shorter spinules are very slender and much more numerous. The edges of these plates are bordered by one or two rows of small, slender, elongated, short, curved spinules or papillæ, which meet across the rather deep sutures, thus forming distinct but loose fascioles. The actinal interradial areas are large and covered with a close pavement of plates, with their outlines concealed by the integument in well-preserved specimens; when the spinules are removed, the plates are squarish with rounded corners, strongly convex, with deep, groove-like sutures between them; they are somewhat irregularly arranged, and form a pavement-like area, in which the rows next the adambulacral plates are parallel with the latter and the outer ones are parallel to the marginal plates, and slightly imbricated; the inner ones are smaller and more numerous than the adambulacral plates, usually one, but frequently two, corresponding to each adambulacral plate; in general they are arranged so that two rows start from each marginal plate, and each row runs to a single adambulacral plate, but an additional row is interpolated in some cases. The row of these plates next to the adambulacral extends out to about the middle of the ray, the distal plates becoming small and narrow. Each of the interradial plates, except those next to the adambulacral series, bears on the middle, one to three, or more, rather large, fusiform, acute spinules, similar to the larger ones on the lower marginal plates, and an irregular open marginal series of much smaller and more slender spinules of nearly the same form, but the plates next the adambulacral have their lateral margins bordered by a regular close series of flattened papillæ, forming distinct fascioles; and occasionally similar fascioles appear on a few of the other plates of the second row. The

adambulacral plates are narrow on the actinal surface, but their inner margin near the adoral end projects into the groove, forming there a prominent angle and leaving deep and broad incurved notches between them; the actinal portion of the projection is rounded and convex, and from its margin arises the furrow-spines, which are nine or ten in number and form an angular group corresponding to the actinal outline of the plate; these spines are subequal, rather slender, elongated, often a little bent outward, and usually laterally compressed and blunt at the tip; they are more or less united at base by a web-like membrane. The small convex actinal surface of the plates bears a central group of about three or four longer, thicker, round or fusiform, usually acute and rough spines, similar to the larger ones of the adjacent interradial plates; beside these there are several much smaller, slender spinules on the outer margin in a curved row. The jaw-plates are rather large and thick, with sharp, nearly vertical, high inner angles, and with a thick, moderately elevated, actinal keel, separated by a rather wide, elongated median suture. Each jaw-plate bears a row of numerous (about eight) slender spines along the edge, next the groove; these are continuous, with a row of four to six similar spines on the inner, vertical margin. Each actinal keel of the jaw bears two irregular rows of slender, excurved, rough spines, ten or twelve in each row; these spines are similar to the larger ones of the interradial plates, but are rather more slender. The ambulacral feet are very large, furnished with a terminal sucker, and occupy the notches between the projecting adambulacral plates.

Taken by the U. S. Fish Commission steamer *Albatross* in 1886 at station 2706, off George's Bank, N. lat. 41° 28′ 30″, W. long. 65° 35′ 30″, in 1,188 fathoms, 7 specimens (No. 14944, U. S. N. M). Also at other stations in 1883, in 123 and 1,255 fathoms.

Variations.—The variations, so far as observed, are probably all due to difference of age. The smallest specimen has the lesser radius, 12 mm.; the greater, 35 mm. This has 27 marginal plates, both above and below. The granulations on the upper marginal plates are more uniform than in the large specimens, those near the lower end of the plate not being much longer than the upper ones, but otherwise they have the same character and are pretty evenly spaced. The paxillæ of the dorsal surface are much smaller and mostly circular, or nearly so; the larger ones have three to nine central granules and twelve to eighteen marginal papillæ. The madreporic plate is very small, about midway between the center and the margin. The spinulation of the inferior marginal plates and interradial region is similar to that of the larger examples, except that the spinules are smaller and more slender. In the furrow series each group contains seven or eight spines, which are slender and slightly excurved, but they are arranged as in the adult; the actinal surface of the plate often bears one or two larger central spines, with four or five smaller and more slender ones on the outer

margin. The jaw-spines are slender, but three or four of them, at the inner end of the incurved jaw, are much stouter than the rest; the inner end of the jaw is prolonged inward and upward to an acute tip.

This species is more closely allied to *P. intermedius*, Sladen, than to any other species hitherto found off our coast. The latter has a smaller disk, with the upper marginal plates projecting farther inward, thus producing a broader margin and a narrower paxillary area along the rays; its paxillæ are smaller in specimens of the same size, more closely crowded, and have the granules closely crowded together and angular, the whole set forming a compact group, in which the marginal papillæ differ but little from the other granules. The upper marginal plates are also much more closely and uniformly covered with granules, which are so closely crowded together that they have a polygonal form, especially on the upper portion of the plates, where they are smaller than below.

The lower marginal plates are also much more densely spinulated and usually have but a single series of a few enlarged, median spinules, not much larger than the rest, while the others are small, short, appressed, crowded, and more or less closely imbricated; those on the lower part of the plate are ovate and often subacute, while those at the upper end of the plate become polygonal and granule like, and similar to those of the upper plates; their marginal papillæ are also characteristic, being short, thick, angular, and very closely arranged in a regular row. The interradial areas are relatively smaller, with more numerous, closer, and smaller, shorter spinules, of which one, a little larger and longer, usually occupies the center of each plate, while the others mostly surround the margin and form distinct fascioles between most of the plates in our numerous specimens (though, according to Sladen, no fascioles existed in his specimens). The adambulacral spines are more equal and form more regular and more prominent groups, the outer marginal ones being more numerous and forming a more regular, divergent, curved series, while the central ones form a group of five to seven larger ones, about equal in length and size to the furrow series; the latter form an angular group of seven to nine, which are usually strongly transversely compressed and blunt. The jaw-spines are much more numerous, stouter, and more crowded; they form a conspicuous, broad-ovate group on the actinal surface of each jaw, with the narrow suture in the middle.

This species has a striking resemblance to *Isaster bairdii* in form and in the character of the abactinal region and upper marginal plates. The disk, however, is somewhat smaller and the rays relatively longer. The paxillæ are a little smaller and the granulations somewhat finer in specimens of the same size; moreover, their marginal granules are finer instead of coarser, as in the latter. However, the strong spinulation of the lower surface and inferior marginal plates is widely different from the even granulation of *I. bairdii*. The angular groups of adam-

bulacral spines also give a very different character to the inferior surface.

Family ASTROPECTINIDÆ (Gray, 1840) emended.

ASTROPECTEN AMERICANUS, Verrill.

Archaster americanus, VERRILL, Amer. Journ. Science, XX p. 402, 1880.

This abundant species appears to be a true *Astropecten*, although a dorsal pore is visible. It has well-developed superambulacral plates. It is more nearly allied to the East Atlantic species, *A. mesactus*, than to any other species described by Sladen. It differs from that species in having longer arms and a much smaller disk; in having longer and more slender marginal spines, and of these usually but two, sometimes three, on each of the inferior row of plates, instead of four or five; in the numerous long, slender spinules of the rest of the surface of the inferior marginal plates; in the long, slender spinules of the dorsal paxillæ, and in the longer and more numerous adambulacral spines.

LEPTOPTYCHASTER ARCTICUS, Sladen.

Leptoptychaster arcticus, SLADEN, *op. cit.*, p. 189.
Astropecten arcticus, M. SARS, Reise, Lofoden and Finmarken, Nyt. Mag. Nat., VI, p. 161, 1851.
Archaster arcticus, VERRILL, Amer. Journ. Science, XVI, p. 214, 1878
Leptoptychaster arcticus, var. *elongatus*, SLADEN, *op. cit.*, p. 189.

Our series of specimens show various gradations in the relative length of the rays, some of them agreeing in this and other respects with the form described as a variety by Sladen. His variety was taken off New Jersey, in 1,350 fathoms. I am unable to make out any definite diagnostic characters for this form.

This species has been taken at many stations off our coast, in 50 to 547 fathoms, but always in small numbers.

PSILASTER FLORÆ, Verrill.

Archaster floræ, VERRILL, Amer. Journ. Science, vol. 16, p. 372, 1878. Rep. U. S. Com'r Fish and Fisheries, XI, p. 542, pl. 13, fig 36, 1885

This species clearly belongs to the genus *Psilaster*, as defined by Sladen. It is closely allied to *P. andromeda*, of Northern Europe, and may eventually prove to be only a variety of that species.

It approaches nearest to those specimens of the latter, mentioned by Sladen, having broad superior marginal plates and well developed spines in a submarginal row on the lower series. Some of the larger examples have a single, enlarged, acute spinule, like those of the lower series, on some of the superior marginal plates.

This species has been taken at numerous stations by the U. S. Fish Commission in 72 to 984 fathoms.

A considerable number have also been received from the Gloucester

fishermen, taken on the fishing banks off Nova Scotia and Newfoundland, in 84 to 230 fathoms.

BATHYBIASTER ROBUSTUS, Verrill.

Archaster robustus, VERRILL, Amer. Journ. Science, XXIX, p. 383, 1885.
Phoxaster pumilus, SLADEN, *op. cit.*, XXX, p. 236, pl. 15, figs. 3-6; pl. 40, figs. 7-11, 1889 (Young).

This species is evidently very closely related to *B. pallidus*, of Northern Europe, the type of the genus *Bathybiaster*. It is even possible that they may prove to be identical when a full series of each can be compared.

The form described as *Phoxaster pumilus* by Sladen, which was taken off the North American coast, in 1,240 to 1,700 fathoms, appears to be identical with the young of our species. His specimens were only 62 mm. in diameter. The genus *Phoxaster* in this case becomes a synonym of *Bathybiaster*.

Fully grown examples of *B. robustus* are often 250 to 280 mm. in diameter.

In the young specimens, up to about 75 mm. in diameter, the central "epiproctal cone" is still visible as a low wart-like elevation, with an aperture in the tip, but in the large specimens it disappears entirely and the central area of the disk becomes flat, or even concave, and covered with crowded paxilliform plates much smaller than those on the rays, but the small central pore is persistent. The peculiar purse-like or bursiform pedicellariæ of the large inner adambulacral spines, characteristic of *Bathybiaster*, are often entirely wanting in our specimens, especially when small, and usually, when present, there are but few of them even in the large specimens. Possibly they may have been destroyed by rough usage in the dredges and washing sieves. The squamiform spinules and pedicellariæ of the actinal and marginal plates are like those of *Bathybiaster pallidus*. The two rows of spinules on each jaw-plate are peculiar, for the opposite spines of each pair press their tips together something like the valves of certain pedicellariæ, but this seems to be the case in the European form also. These spines are subequal in length—short, with flattened blunt tips; those of the actinal series, in large specimens, are stoutest, often with enlarged, truncate, bilobed, or rough ends; there may be 15 to 20 in each row. The two close parallel rows of spines on the first adambulacral plates are similar in form and arrangement. Of these there may be 10 to 12 in each row. The adambulacral plates, except the first pair, correspond in number to the marginal plates. The actinal interradial plates form short, simple rows running from each plate to a corresponding marginal plate; their marginal scales form narrow fascioles, which become more distinct and regular in the narrow, continuous vertical grooves between both series of marginal plates. The longitudinal sutures between the upper and lower plates are very

inconspicuous. The small, conical, marginal spine on the upper edge of each of the superior plates is relatively shorter and stouter in the large specimens than in the smaller ones; sometimes there are two of them side by side. Taken at many stations, in 705 to 1,467 fathoms.

Family PENTAGONASTERIDÆ, Perrier.*

PARAGONASTER FORMOSUS, Verrill.

Archaster formosus, VERRILL, Amer. Journ. Science, XXVIII, p. 383, 1884.
?*Paragonaster cylindratus*, SLADEN, *op. cit.*, p. 314, pl. 51, figs. 3, 4; pl. 53, figs. 3, 4, 1889.

Our species appears to be very closely allied to the form well described and figured by Sladen from off the Cape Verde Islands. Our species appears to have the adambulacral plates more salient and angular on the furrow-margin, and the notches between them deeper; the furrow-spines appear to be more slender and form a more strongly curved or angular group, which is continued by three to five shorter ones in a fasciole-like row on the proximal and distal edges of the plates; there are about five on the furrow-edge proper; the spines on the actinal surface are more elongated and more regularly stellate, with a longer one in the middle of the group.

The spinules of the lower marginal plates have the same arrangement as in Sladen's species, but are slightly more slender and acute than shown in his figure; of the larger median series there are usually two or three irregular, indefinite rows in the larger specimens, instead of a single definite row. These differences are, however, so slight that the two forms may eventually prove to be the same species.

Narrow, imperfect fascioles occur between the marginal and actinal plates in our species.

The distinction between *Paragonaster* and *Pseudarchaster* seems to me very slight, depending almost entirely upon the narrow abactinal area of the rays in the former.

This species was taken at several stations in 1,396 to 2,031 fathoms.

ISASTER, new genus.

It seems necessary to institute a new generic group for the elegant starfish formerly described by me under the name of *Archaster bairdii*. It cannot be placed in any of the numerous genera proposed by Sladen without changing the definitions considerably. It appears to be most nearly allied to *Mediaster*, *Paragonaster*, and *Nymphaster*. It might be defined as a *Nymphaster* with broad rays having wide abactinal areas.

The form is stellate, with a rather broad disk and tapering rays, having rather wide abactinal areas. The marginal plates are well developed in both series, but the upper ones are flattened above, or bevelled, and do not form a wide margin on the disk; they are all paired, and those of the two series are nearly opposite each other. They are everywhere

* *Goniasteridæ* is an earlier and better name for this group.

granulated, without spines, and have differentiated marginal granules along the sutures, forming narrow fascioles. The abactinal ossicles are mostly parapaxillæ, regularly arranged in several longitudinal rows along the middle of the rays, with the central row clearly defined; they are closely and evenly covered with angular granules, those around the edge differentiated. The papulæ are restricted to the central part of the disk and the baso-median part of the rays.

The actinal interradial areas are large and covered with many more or less rhombic plates closely arranged in regular rows parallel with the ambulacral grooves. The plates are covered with even granules similar to those of the upper surface.

Some of the actinal plates usually, but not in all specimens, bear small valvate pedicellariæ, usually with two or three valves, similar in size to the granules; similar pedicellariæ may occur in small numbers on the marginal and abactinal plates.

The armature of the adambulacral plates is in longitudinal rows, usually three rows to a plate.

The jaws are not prominent on the actinal side; they have marginal and actinal rows of spines. The ambulacral feet have terminal suckers.

This genus differs from *Nymphaster* chiefly in having broad abactinal areas on the rays. From *Paragonaster* it differs in that character and also in having the actinal plates evenly granulated, and the furrow-spines in a straight row.

The pavement-like arrangement of the actinal plates, the granulation of the plates, and other characters indicate that it belongs to the family Pentagonasteridæ, as limited by Sladen.

ISASTER BAIRDII, Verrill.

Archaster bairdii, VERRILL, Amer. Journ. Sci., XXIII, p. 139, 1882.

Disk broad, flattened, or moderately convex, with the interradial margins broadly curved, and the edge evenly rounded, owing to the faint elevation of the upper marginal plates. Rays broad at base, rapidly tapered to rather slender tips. Lesser to the larger radius about as 1 to 2.5. Lesser radius of one of the largest specimens, 23 mm.; greater radius, 54 to 56 mm. Another specimen has the lesser radius 18 mm.; greater, 53 mm.

Abactinal area of the disk and rays closely covered with rather large crowded parapaxillæ, which are round or polygonal according to the amount of crowding, with a median row along the rays slightly larger than the others. The parapaxillæ consist of a round, convex, cylindrical or slightly clavate column, arising from the center of each of the plates. On the middle region of the basal portion of the rays, the plates are united by more or less stellate processes so as to leave large intervening pores for the papulæ; but in the triangular interradial areas the plates are closely united, without pores between them. On these areas they become protopaxillæ, and are closely crowded in rows

parallel to the marginal plates; next the marginal plates they become much smaller than elsewhere and squarish or hexagonal in form, while the central column becomes reduced to a slight elevation of the surface. These small plates, without interspaces, also extend along the margins of the rays and fill up the entire abactinal area of the arms beyond the distal fourth, where there are about five rows. In the central area of the disk the central and ten primary plates are larger and more rounded than those upon the rays; and the papular pores are smaller and less numerous than upon the rays, so that the areas having pores form a five-rayed star upon the disk and arms, which is conspicuous when the granules are removed. The petal-like groups of papular pores are also often distinctly visible in dry specimens without the removal of the granules.

Each of the dorsal plates bears a very even and regular flat or concave group of papilliform granules; each group consists of a central cluster of from twelve to twenty-five rather small rounded granules, slightly separated from each other, and of a marginal series of fifteen to thirty or more, somewhat longer, very even, flattened, blunt papillæ, which are somewhat divergent, so that those of the adjacent groups are nearly or quite in contact, except where the papulæ come forth. Owing to the somewhat greater length of the marginal papillæ the central area of the whole group is lower than the margin. Some of the smaller groups towards the sides of the rays contain but six to ten granules in the central cluster, in the midst of which one, slightly the largest, is central and the others form a circle around it. Close to the marginal plate, in the interradial areas, where the plates are most crowded, the granules become very uniform in size and elevation, so that the separate groups are scarcely distinguishable and the granulation is nearly identical with that on the marginal plates.

On several of the largest specimens many of the dorsal plates, both of the disk and rays, bear a single, small, subcentral or marginal bivalved pedicellaria, which is a little higher than the adjacent granules and two or three times as broad; seen from above the outline is oblong; each one appears to take the place of from two to four granules. Sometimes two such pedicellariæ occur on the same plate, and occasionally they have three valves. Those that occur near the interradial margins are smaller than those on the central area. The valves are flat, incurved, and truncate at the end.

The madreporic plate is small, with few branched gyri, and is situated much nearer to the center than to the margin; in a specimen having the lesser radius 22 mm. the madreporic plate is 7 mm. from the center. The central or anal pore is usually small and inconspicuous, but in some specimens it is very evident and is surrounded by a convergent group of numerous small spinules. In the papular areas at the bases of the arms the pores are large and each has a single papula; usually each plate is surrounded by six pores.

The upper and lower marginal plates closely correspond in number and elevation. The superior ones are scarcely raised above the level of the disk, so that they are not conspicuous, as seen from above. In the interradial areas they are nearly twice as high as long, but beyond the middle of the arm they become squarish in form; their surface is but slightly convex; they are separated from each other and from the inferior plates by shallow and narrow grooves, which are bordered by a row of small granules or papillæ a little longer than those that cover the rest of the plate, so as to form simple fascioles. In the largest specimens there are about twenty-five superior marginal plates on each side of a ray. The inferior plates are nearly the same as the superior ones in size and form and in the furrows or fascioles between them, but the sutures do not always correspond precisely with those of the upper series. The entire outer surface of the marginal plates of both series is covered with small granules separated by intervals less than their own diameters.

The interradial areas beneath are rather large, triangular, and occupied by groups of closely united, convex, polygonal, and squarish plates, similar in size to the larger ones of the dorsal surface and covered by even groups of granules, much like those of the dorsal surface, but a trifle larger and higher. These plates form four or five regular rows parallel to the adambulacral plates on each side, beside a small triangular group next the center of the interradial margin; their regular arrangement and squarish form allows narrow furrows to run from between the adambulacral plates to the marginal plates in both directions. Those in the row next the adambulacral plates correspond nearly to the latter in number and breadth; this row extends to a point about opposite the eighth marginal plate of the ray, the distal plates becoming small and irregular and only filling the angles between the adambulacral and marginal plates; but within the limits of the disk the plates of this row are nearly square, with rounded corners. The granules covering these actinal plates are somewhat elevated, with rounded and somewhat swollen tips, the marginal series on each plate being somewhat longer and more divergent than the rest, so as to form rudimentary fascioles between the plates. The number of granules on the larger plates is usually from fifteen to twenty, of which three to six occupy the center of the group, while the others are often arranged so as to form pretty regular square or rhombic groups, giving a very even and symmetrical arrangement to the whole area. On some of these plates, near the mouth, one of the central granules is replaced by a small bivalved pedicellaria, similar in size and form to the adjacent granules, but they do not appear to be present on all specimens. In some specimens these pedicellariæ become decidedly larger and are furnished with three, four, and even five valves surrounding a central or subcentral pore in a plate; in this case they take the place of the central group of granules and become more numerous and occur on about one-third of all the

interradial plates. On such specimens more or less similar two-valved pedicellariæ are found on the marginal plates and on the abactinal plates of both the rays and disk. The adambulacral spines consist, in the larger specimens, of an inner or furrow-group of five or six rather slender elongated spines, which arise from a curved and prominent base line and project inward in a more or less divergent group, in which the middle spines are somewhat longer than the rest; these spines are mostly flattened in a direction transverse to the rays and are subacute at the tip; external to these, on the actinal side of the plate, there is a somewhat curved longitudinal row of about six spines, which are much shorter than the inner ones, their length being less than half, while the three middle ones are also somewhat stouter than the inner or furrow-spines, and considerably larger than those adjacent to them in the same row; each plate bears also an outer, incurved marginal series of short, blunt spinules, scarcely larger than and similar to the granules of the adjacent plate. They form a marginal row around the outer portion of the plate, and often form, with the median series, a more or less circular or elliptical group, external to the furrow series; but in other specimens the two sets appear rather as parallel, longitudinal rows. The furrow ends of the adambulacral plates are broadly curved and prominent and project somewhat into the furrow, leaving rather deep indentations between them, which form rudimentary fascioles.

The jaws are furnished with numerous rather stout, flattened spines, of nearly equal size; of these, about three projecting inward from the angle of the jaw are a little the longest, and the median one is a little more prominent than the others. Distal to these, on each margin there may be eight to ten somewhat smaller, blunt, transversely compressed spines standing in a single row. The actinal surface of the jaw-plates is slightly convex and but little prominent, the two plates forming together a broad oval, upon which, proximally, there is a pair of short, rather stout, angular spines, which form the apex of an oval group of smaller and shorter spines, formed by two rows on each half of the jaw; the more distal of those of the outer row, and all those of the inner rows, are similar in size and form to the granules of the adjacent interradial plates.

This species was taken by the U. S. Fish Commission steamer *Albatross* in 1882 at station 1122, off Martha's Vineyard, in 351 fathoms, and at five stations, in 1885, between N. lat. 42° 55′ 30″, W. long. 50° 51′, and N. lat. 39° 47′ 07″, W. long. 70° 35′, in 471 to 721 fathoms.

Most of the specimens, including all the larger ones, were taken at stations 2429 and 2552, in 471 and 721 fathoms.

Variations.—The essential characters of this species do not vary largely in specimens much smaller than those described. The smallest specimen seen has the radius of the disk 8 mm. and that of the rays 18 mm. This specimen agrees closely with the largest in general appearance and most of the details of structure. But the dorsal parapaxillæ

are naturally smaller and are occupied by a much smaller number of granules, there being on the median row of the rays about ten or twelve marginal and three or four central granules. The primary plates are relatively larger than in the adults. The larger ventral interradial plates have about seven to ten marginal granules, and usually but one in the center. The spines of the adambulacral plates form three pretty regular longitudal rows; those of the inner or furrow-series are long and slender and form a divergent group, usually of four on each plate; in the second row there are mostly four, which are much stouter, on each plate; the outer row consists of from three to five on each plate, similar to the adjacent granules. On the young specimens up to 50 mm. in diameter no pedicellariæ have been observed. A few often occur on specimens 70 mm. in diameter, but they are often absent from the largest sized specimens.

Most of the specimens from station 2429 have the arms somewhat longer and more attenuated distally than in the typical specimens. One of these, having the radius of the disk 14 mm., that of the rays 42 mm., has the rays 6 mm. in the breadth in the middle, measuring from the mouth.

A single six-rayed specimen occurred at station 2429. This is 54 mm. in diameter; radius of the disk 10.5 mm. It agrees pretty closely with the five-rayed specimens of similar size, but the granules of the actinal plates are smaller and more numerous than usual, and many two-valved pedicellariæ occur upon both the dorsal and ventral plates. In this specimen the furrow-series of adambulacral spines consists of groups of six and sometimes seven on each plate.

Genus ODONTASTER, Verrill.

Odontaster, VERRILL, Amer. Journ. Science, XX, p. 402, 1880.
?Gnathaster, SLADEN, *op. cit.*, p. 185, 1889.

This genus has a broad, stellate form, usually five-rayed. The abactinal surface is covered with elevated, round parapaxillæ, bearing spinules. The papulæ occupy the center of the disk and the median part of the rays. Marginal plates convex, the two series about equally developed with an odd interradial one in each series. Imperfect fascioles occupy the sutures. Upper marginal plates covered with fine spinules; lower ones with larger spines, similar to those of the lower surface of the disk. Actinal plates numerous, pavement-like, in rows parallel to the furrows, each with a group of erect spines. The adambulacral plates are rather rectangular, with a furrow series of few large spines in a simple row, and an actinal group of similar large spines. Each jaw has on the actinal side and near its inner end a large, sharp median spine or tooth-like process, which is directed outward. The jaws have marginal and actinal rows of spines similar to those of the adjacent plates. No pedicellariæ have been observed.

In most respects the genus *Gnathaster* of Sladen is identical with

Odontaster. The large, median, sharp, recurved spine or "keel" of the jaw is the same in both, and the same is true of the general structure of the skeleton. But *Odontaster* is much more spinose, both above and below, than any of Sladen's species. The latter have more evidently paxilliform plates on the actinal surface, bearing small spinules or papilliform granules, while in the type of *Odontaster* all the ventral plates are densely covered with long, robust, erect spines, nearly equal in length.

ODONTASTER HISPIDUS, Verrill.

Odontaster hispidus, VERRILL, *op. cit.*, p. 402, 1880.

This form is regularly stellate, with a rather broad, flat disk and tapering, subacute rays, which are usually 5, but sometimes 6. The dorsal surface of the disk and rays is covered with spinulated para-paxillæ; over most of the surface these have a rather high, round, central column, convex at summit, and covered with a dense radiating group of long, slender, sharp spinules, often 20 to 26 on each; the marginal spinules are smaller and mostly divergent. Toward the margins of the interradial areas and rays the central column of the plates becomes gradually smaller and shorter, becoming verruciform and quite small on the outer plates, which are closely crowded and without intervening papular pores.

The papulæ, in specimens 20 to 30 mm. in diameter, are arranged in a broad ovate group at the base of each ray, and in a disconnected central group on the disk, but in large specimens the central group becomes connected with the others by a narrow median band; the papulæ do not extend quite to the end of the rays in the largest examples, but reach to about the distal third. The madreporic plate is of medium size, with fine gyri, and is surrounded by a ring of about 6 paxillæ.

The marginal plates are all convex, with deep rounded sutures, in both directions; the upper ones rest largely on the dorsal side. There is an odd interradial marginal plate in each series, very similar to the others, but a trifle more wedge-shaped. There are usually 17 to 19 plates in each series, in the larger specimens; they are opposite each other. The apical plate is small and pear-shaped.

The upper marginal plates are densely covered with small, slender spinules, like those of the dorsal paxillæ, and the marginal ones are smaller and form narrow fascioles.

The inferior marginal plates are densely covered with similar spines, which are a little more acute, but they have very slender spinules along the sutures, forming imperfect fascioles. The actinal plates are numerous, thick, rather squarish, but with rounded angles and a convex surface, with pits where the spines are removed; they are arranged in rows parallel to the furrows, except close to the margin, where they become small, irregular, and crowded; those in the first row are longer radially than the adambulacral plates, so that they are fewer than the

latter; those in the other rows have a tendency to stand opposite those of the first series, those in each succeeding row being smaller, but this arrangement is not entirely regular. The first row of actinal plates extends to within a short distance from the end of the rays, only the last 4 pairs of marginal plates being without them, but they become small and narrow distally.

The adambulacral plates are rectangular, shortest radially, convex, separated by well-marked sutures. The larger specimens have either 2 or 3 rather long and nearly equal, erect, furrow-spines, on each plate, and about 5 or 6 similar, but slightly larger, erect spines on its actinal surface; these spines are all pointed and quite identical, in size and form, with those of the adjacent plates.

Specimens of ordinary size have the smaller radius about 16 mm.; the larger radius 40 to 42 mm. A few 6-rayed specimens have occurred. This species was taken at a large number of stations by the U. S. Fish Commission, in 43 to 1,230 fathoms, between N. Lat. 35° 14′ 20″ and 40° 10′ 15″.

PENTAGONASTER EXIMIUS, new species.

A small, flat species, with a broad, pentagonal disk, nearly rectilinear on the interradial margins, and with small, short, narrow rays, which are obtusely rounded at the end, owing to the presence of a rather large apical plate. The lesser to the greater radius, as 1 to 1.75. Lesser radius of the best specimen, 16 mm.; greater radius, 25 mm.; elevation of the margin of the dry specimen, 3 mm.; length of the largest marginal plates, 2 mm.; diameter of the largest dorsal paxillæ of the rays, 1.2 mm.

The abactinal surface is closely covered by nearly flat, rather large, closely granulated plates, which, in the radial areas, are regularly hexagonal at summit, a central median series being distinguishable, though scarcely larger than those adjacent. The central area of the disk is occupied by angular plates, more irregular in size and form, among which all the central and the 10 primary radial and interradial plates can be easily distinguished by their much greater size and more numerous granules, their diameter being about 2 mm., and the number of granules more than 100. The large triangular interradial areas, destitute of papulæ, are occupied by very closely arranged angular plates, some of which are rhombic, others trapezoidal, and some subtriangular, those nearest the marginal plates being smaller than the others, but all are covered with a uniform granulation. On the larger radial plates there is a central group of 15 to 20 closely packed, rounded granules and a marginal series of from 20 to 25 angular ones. On the distal part of the rays the median plates become smaller and more irregular, and have no intervening papulæ, and between the last three pairs of marginal plates they are absent. The madreporic plate is small, angular, and nearer to the center than the margin (distance from center, 6 mm.); it has rather few convoluted gyri.

Of the upper marginal plates there are 8 on each radial margin, and of the lower plates, 9, including a very small one next the apical plate. The larger plates of the upper series are nearly rectangular in outline, but rather higher than long; as they approach the end of the rays they become relatively shorter, until, near the end of the ray, the length is about one-half the height. The inferior plates are about equal in size to the upper, and stand nearly opposite to them, but the sutures do not correspond closely; the larger part of their surfaces extend upon the actinal side of the interradial region. The entire surface of the plates of both series is densely covered with small polygonal granules, except a small, rounded, or oval, bare spot on the upper end of each superior plate, and near the lower margin of each inferior plate; but these smooth bare spots are occasionally wanting, and vary in size, indicating that they may have been caused by injury before capture, for the plates are pitted where the granules have subsequently been removed.

The large interradial areas of the actinal side are occupied by a close pavement, mostly of rhombic plates, which are mostly arranged in rows parallel to the ambulacral groove. Each plate is covered by a compact group of angular granules, usually 10 to 15 on each plate; these granules are coarser and more elevated than those on the surface of the marginal and dorsal plates, but they are all similar and of the same height, producing a very even surface. The adambulacral plates are arranged in 3 nearly regular longitudinal rows; the furrow-series consists usually of 3 nearly equal spines which are moderately stout, not very long, mostly flattened, and obtuse; the next series is formed by 2, somewhat flattened, blunt spines, side by side, on the actinal side of each plate; these are a little shorter, and decidedly stouter than the furrow-series; the outer series is formed by 3 small, equal, angular, granule-like spinules on the outer margin of each plate; they are similar to and only slightly longer than the granules of the adjacent plates. The jaws bear, on each side, a row of 8 or 9 rather stout and short angular spines of which the innermost are a little the largest and also a row of similar spines, of about the same size, on each actinal border, with a few smaller ones in a group at the distal end. The jaws have no distinct actinal keel.

This species was taken by the steamer *Albatross* in 1883, off La Have Bank, at station 2064, N. lat. 42° 25′ 40″, W. long. 66° 08′ 35″, in 122 fathoms, and in 1885 off Nova Scotia at station 2507, N. lat. 44° 27′ 30″, W. long. 62° 33′ 30″, in 80 fathoms. A single specimen was obtained at each locality.

This species is closely allied to *P. granularis*, which is also found in the same region. The latter differs in having the interradial margin more regularly incurved, with the rays relatively longer and more regularly tapered and the tip less acute, owing to the smaller size of the apical plate; the granulations of the abactinal marginal plates are also

coarser and less even, and not so numerous; the primary interradial plates are relatively much smaller and less distinct from the others; the madreporic plate is finely cancellate; the adambulacral plates bear more numerous, stouter, and more angular spines; in the furrow-series there are usually four or five spines; on the middle of the actinal surface three to five stout, blunt, angular spines; and on the outer margin usually three or four short, thick, angular, granule-like spines.

Remarks on the characters of the preceding families.

The preceding families Archasteridæ, Astropectinidæ and Pentagonasteridæ, as limited by Mr. Sladen,* are not well defined, nor do the few characters given by him hold good in all cases.

The existence of superambulacral plates has been supposed to be characteristic of the Astropectinidæ only, but they exist in several of the genera referred to Archasteridæ, viz., *Dytaster*, *Plutonaster*, and *Pseudarchaster*.

The aproctous condition, supposed to be characteristic of the same family, is unreliable, for in nearly all the genera referred to it by Mr. Sladen there is a perfectly well defined dorsal or "anal" pore appearing just as in the Archasteridæ, and in some of the genera the pore is even elevated on the summit of a dorsal cone or chimney (*Psilaster*, *Ilyaster*, etc.). This pore serves in each of these families (and in Asterioidea generally) for the discharge of the secretion of branched dorsal glandular organs, probably nephridial in function, situated above the stomach.

Whether the central pore serves as a true anus in any of these starfishes is very doubtful, for the intestine is usually nearly or quite abortive. In any case it is impossible to ascertain this point without actual dissection of alcoholic or fresh specimens, which are often not available.

The distinctions between the Pentagonasteridæ and Archasteridæ are also very faint and indefinite, for although the typical genera of each group appear to be very different, there are many intermediate genera now known, so that there is probably not one diagnostic character that can be given to separate the two groups as limited by Sladen. If the two families are to be preserved, it will probably be necessary to change their limits and to transfer some of the genera.

It would, perhaps, be more in accordance with a natural classification to drop the family Archasteridæ and distribute the genera referred to it among those of the other two families. In such a system those genera having distinct fascioles between the marginal plates and between the infero-radial plates would belong with the Astropectinidæ, while those without fascioles would be placed in the Pentagonasteridæ or Goniasteridæ.

By this rearrangement the former family would include mostly those genera covered with true paxillæ and parapaxillæ, and the latter would

* Voyage of the Challenger, XXX, pp. XXVIII–XXXI, 1, 174, 260, 1889.

include mostly genera covered with spinous or granulated plates, protopaxillæ, or pseudopaxillæ.*

The various kinds of abactinal ossicles pass into each other by various intermediate forms, so that it is impossible to draw any very strong or sharp family lines on this character alone, though the character of the plating may generally be taken as of generic value.

The existence of definite fascioles of specialized spinules or papillæ on the margins of the plates, so as to form covered channels along their sutures, is evidently a character both of morphological and physiological importance. The existence of fascioles is correlated with the mode of life. Such forms as have them appear to live more or less buried in soft mud or sand and the fascioles are evidently for the purpose of providing a free circulation of water around the whole surface of the body, both to provide for respiration and to keep the surface of the body free from dirt. The paxilliform plates also contribute to both these functions.

The typical Astropectinidæ are among those best provided with fascioles and with the most highly developed forms of paxillæ. They are also those that are eminently dwellers in and beneath mud and sand. The pointed form of the ambulacral feet is correlated with the same habit.

The family Porcellanasteridæ includes *Ctenodiscus*, *Porcellanaster*, and allied genera, which have similar, but even more specialized, structural adaptations for the same purposes.

Within the limits of the family Archasteridæ Mr. Sladen made four

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*It seems desirable to have special terms to designate these various forms of dermal ossicles, which are generally included rather indefinitely under the terms paxillæ and pseudopaxillæ. As understood by me, true *paxillæ* are columnar or hour-glass-shaped ossicles with narrow, usually isolated, bases, which bear at summit a group of small spinules, of which the marginal series are usually different from the rest and divergent, so as to cover the intervening spaces between the spines. These are highly developed in most species of *Astropecten*.

Spinopaxillæ are of the same general structure, but the center of the summit is occupied by a distinct spine, or by more than one. Such forms occur on *Luidia*, *Pontaster*, etc.

Parapaxillæ are lower and broader, rounded ossicles, or angular plates with a raised central portion, or like a low column; they may be either isolated or articulated by their bases; the summit is covered with small, short, differentiated spinules, much like those of true paxillæ. Those on the dorsal surface of *Plutonaster* are examples. They sometimes bear a central spine.

Protopaxillæ are similar, but less elevated convex ossicles or plates, covered with round or angular granules, with the marginal series differentiated and more or less covering the grooves between the plates. As in the preceding, there may be a central spine in some cases. This form occurs on *Plutonaster*, and on many species of Pentagonasteridæ. The transition from this last kind to simple, uniformly granulated plates is easy, when the grooves between the plates become obsolete.

Pseudopaxillæ are plates with flattened, often lobed or branched, and mostly overlapping bases, which bear a group of slender, fascicled spinules, on the more or less raised central or subcentral area. These have no differentiated marginal series of spinules. This form is well seen in *Solaster*, *Cribrella*, etc.

subfamilies. These are mostly small groups of genera that have more or less close relations to each other, but the distinctions between some of them seem to me too slight for even subfamily groups. Every new genus discovered is likely to break down some of the distinctions made between such groups. Moreover, some of the distinctive characters given by Mr. Sladen do not hold good for the genera classified by him. Thus, the subfamily Pararchasterinæ is said to have the papulæ "confined to a limited area at the base of the rays," while the subfamily Plutonasterinæ is said to have them "distributed over the whole abactinal area." But, as a matter of fact, scarcely any of the genera referred to either of the subfamilies have the papulæ so distributed, and in many of the genera they can be best described as confined to the central part of the disk and to the median or radial areas of the basal part of the rays and disk. They are almost always lacking on the distal and submarginal parts of the rays, and on more or less extensive dorsal interradial areas of the disk. This is the case in *Plutonaster*, *Dytaster*, *Pseudarchaster*, etc., and is also the usual arrangement in the Pentagonasteridæ.

The genus *Pararchaster*, Sladen = *Benthopecten*, Verrill has essentially this same arrangement of papulæ, only they are absent from a somewhat greater portion of the distal part of the ray, but different specimens of the same species vary widely in this respect according to their age. In fact, there is nothing very peculiar in their arrangement in this genus, as compared with various other species formerly included in the genus "*Archaster*," so that when the genus *Benthopecten* was first briefly described by me I did not consider it necessary to refer to this feature, there being various other characters of much greater value.

The special arrangement of the papulæ in *Pontaster* is, however, a character of importance. But there is surely no very close affinity shown between *Pontaster* and *Benthopecten* by the arrangement of the papulæ.

My own view is that *Benthopecten* may be more closely allied to some of the genera referred to the Pentagonasteridæ by Mr. Sladen, for it has neither paxillæ nor fascioles, but it does have large, odd, interradial marginal plates, a feature found in some of the other genera of the latter family. Probably there should be a special subfamily, *Benthopectininæ*, established for it.

On the other hand, a special subfamily, *Pontasterinæ*, may well be established for the genus *Pontaster* and allied genera, which are evidently closely related to the more typical genera of Archasteridæ.

A very remarakable new genus of this group, and apparently closely allied to *Pontaster*, though it has large papular areas, exists on the Pacific coast. It has the following characters:

ACANTHARCHASTER, new genus.

Rays usually five, long, angular, tapered. Disk small; actinal interradial plates very few, spinous, confined to the disk; marginal plates

of moderate size, more or less alternate, spiniferous; those of the upper series smaller than those of the lower, rounded, with a central eminence bearing a single large movable spine, with a group of small spinules around its base. The plates of the lower series may bear two or more similar large spines surrounded by spinules. The upper marginal plates form a narrow margin along the rays.

The dorsal surface is covered with small, unequal plates in the form of protopaxillæ and spinopaxillæ; the latter have a low, round column and bear a large, central, articulated spine surrounded at base by a circle of small spinules; they are found on the disk and along the median part of the rays. The protopaxillæ are smaller and part of them bear only small spinules; others have a small central spine.

The papulæ cover most of the disk and the entire basal part of the rays.

Peculiar double pectinate pedicellariæ exist on the dorsal surface of the rays and disk, and a single one, of larger size, occupies the center of each actinal interradial area; in one case a similar structure replaces the two upper marginal plates in the interradial angle. These large actinal compound pedicellariæ may have ten to twelve incurved papillæ on each side, while those of the dorsal surfaces have, usually, three to six. Some of the latter have three convergent groups of curved papillæ. The central dorsal pore is very evident and surrounded by papillæ.

The adambulacral plates have a salient inner angle, and bear a divergent group of furrow-spines and a transverse actinal row of long spines.

The jaw-plates are large, and bear simple marginal and actinal series of long spines.

The type (*Acantharchaster dawsoni*, Verrill), originally described* as *Archaster dawsoni*, Verrill, was taken in 111 fathoms off the Queen Charlotte Islands.

Family STICHASTERIDÆ, Perrier.

NEOMORPHASTER FORCIPATUS, new species.

Rays five, high and rounded at the base, tapering rather rapidly to the slender, acute tips, and in the dry specimen showing a distinct, elevated median row of large plates and four lateral rows of somewhat smaller plates on each side. Interbrachial angles subacute; disk rather small, swollen, in the dry specimen depressed in the center. The lesser to the greater radii are about as one to five. Smaller radius of the type specimen, 16 mm.; greater radius, 85 mm.; breadth of arms at base, 19 mm.; height of the arms at base, 16 mm.; diameter of madreporic plate, 4 mm.

The disk and the principal rows of dorsal plates of the rays are

* Report of Prog., Geol. Survey of Canada, 1878–1879.

covered with short, thick, blunt, almost granule-like spinules and with a great abundance of comparatively large crossed pedicellariæ, which are also scattered over all the plates, both of the dorsal and lateral surfaces of the arms and disk; many of these pedicellariæ are nearly as large as the adjacent spinules and about half as thick as the larger spinules of the dorsal series. The rows of plates along the sides of the arms are destitute of spinules, but are thickly covered with pedicellariæ. Adjacent to the adambulacral plates there is a row of stout ventral plates, each of which bears two stout, obtuse, club-shaped spines placed side by side and forming a somewhat irregular row, which terminates before reaching the middle of the arm. Outside of these there is another row of prominent plates, each of which bears one or two small spines toward the base of the arms, but beyond the middle of the arm each bears two spines or sometimes three, like those of the inner row. The surface of these large ventral plates is covered, like the dorsal and lateral ones, with large crossed pedicellariæ. Each adambulacral plate bears two or sometimes three moderately long, round, blunt, and often slightly clavate spines, so arranged as to form two pretty regular rows. Near the mouth each plate usually bears a single spine forming a simple row. Attached to the adambulacral spines and in the ventral interradial spaces are many acute, ovate, forcipate pedicellariæ, often mixed with crossed pedicellariæ and scarcely exceeding the latter in size; along the inner edge of the adambulacral furrow there are numerous smaller pedicellariæ similar in shape. Many of these are raised on slender pedicles; they often form a group of three or four on the inner end of each plate. Jaws elongated, with three or four rather long, round, subacute spines in a row along each side, and with four longer convergent spines at the inner end, two of which are directed upward and inward.

The central part of the disk is covered by a system of rather large primary plates, which form a more or less distinct rosette. The madreporic plate is near the center, moderately large, flattish or somewhat concave, and surrounded by numerous spinules like those of the neighboring plates. It occupies the whole upper surface of a large primary basal plate. The plates of the median dorsal series are rather large and prominent, closely united in a continuous series; their prominent crests are transverse and bear about 10 to 12 spinules, which are arranged in about two irregular transverse rows, intermingled with the pedicellariæ; another row of similar but somewhat smaller plates extends from the dorsal interradial angle to the tip of the arm on each side; this row, at first dorsal, becomes median-lateral at about the middle of the ray. Toward the base of the arm these plates usually bear a transverse row of 2 to 4 small spinules on a distinct crest or ridge, but these mostly disappear before reaching the middle of the arm; between this row of plates and the median dorsal row on the basal part of the arm there is an intermediate row of smaller plates,

most of which bear a small group of spinules and pedicellariæ, but this row becomes indistinct at about the middle of the arm, yet continues to the end. The sides of the arms at the base are occupied by about three rows of large, close plates, mostly without spinules. These longitudinal rows of plates are united by short, stout, transverse processes, so that they leave small rounded interspaces, each of which bears a group of 3 to 6 or more papulæ on the dorsal surface; on the lower lateral and ventral surfaces the interspaces become much smaller, and the papulæ often stand singly. All the plates are very firmly united together, both transversely and longitudinally, so that their outlines can not be distinguished in the dry specimen without maceration.

The ambulacral sucker-tubes form 4 close rows, and are furnished with small terminal suckers.

Two specimens (Nos. 11131 and 11425, U. S. N. M.) were taken in 1885 at stations 2530 and 2531, off George's Bank, in 956 and 852 fathoms; and another in 1886 (No. 14859, U. S. N. M.) at station 2681, off Martha's Vineyard, in 990 fathoms.

The generic position of this singular species is somewhat doubtful. It appears to be more nearly allied to *Neomorphaster eustichus*, Sladen, from off the Azores, in 900 to 1,000 fathoms, than to any other described form. It differs, however, in having more numerous pedicellariæ scattered over the surface, in the greater number of papulæ, in the transverse arrangement of the dorsal spinules, and in having longer and more slender furrow-spines.

Family SOLASTERIDÆ, Perrier.

SOLASTER SYRTENSIS, new species.

Rays usually 9, well rounded above, high at base, regularly tapered, moderately long, the length about equal to the diameter of the disk. Interradial angles subacute, occupied by close psuedopaxillæ. Disk flattened or convex, according to the mode of preservation. Radii about as 1 to 3. In one of the type specimens, the diameter is 165 mm.; lesser radius, 28 mm.; greater radius, 80 to 85 mm.; breadth of rays at base, 18 mm.; height of rays at base, 16 mm.; diameter of dorsal pseudopaxillæ, about 0.75 mm; diameter of madreporic plate, 3 mm.

The whole dorsal surface and the sides of the rays are closely and evenly covered with rounded, flat-topped pseudopaxillæ, larger and more even than those of *S. endeca*. Those covering the central area of the disk and middle of the basal part of the rays are largest, the size regularly decreasing toward the ends and outer sides of the rays. The spinules on the largest pseudopaxillæ are often 30 to 40 in number, of which 20 to 25 or more surround the margin, while 6 to 12 or more form a central group. They are all similar—small, slender, of moderate length, and rough at the blunt tips, and seem to be united at their bases by a membranous web.

When the spinules are well preserved those of adjacent pseudopaxillæ are nearly in contact, giving the surface an even and somewhat tessellated appearance. The pseudopaxillæ on the sides of the rays form regular oblique rows, diverging downward and outward.

The papulæ are large and occur either singly or in groups of two or three in each small interspace between the dorsal plates of the disk and arms; on the sides of the arms they mostly occur singly. No papulæ were found below the marginal plates. Madreporic plate of moderate size, covered with fine, much convoluted gyri Upper marginal plates small, bearing pseudopaxillæ slightly larger than those above them on the basal part of the arms, but becoming much more distinct toward the tips, where the adjacent lateral pseudopaxillæ are small. The inferior marginal plates are much larger and somewhat prominent; the elevated portion is compressed, elongated transversely to the ray, and bears an oblong group of numerous small, crowded paxilliform spinules, similar to those of the dorsal pseudopaxillæ. About 55 lower marginal plates occur on each side of a ray.

The inferior interradial spaces are of rather small size and are closely covered by plates which bear mostly elliptical or oblong paxilliform clusters of small, slender, crowded spinules, similar to those of the marginal plates, but larger than those of the dorsal pseudopaxillæ.

A row of 6 or 8 interradial plates, bearing paxillæ, extends a short distance out on the arms between the marginal and adambulacral plates.

The adambulacral spines are long and slender; in the furrow-series each plate bears a group of 4 (sometimes alternately 3 and 4, or 5 and 4) rather long, tapering subacute, somewhat divergent and nearly equal spines, which stand in a line slightly oblique to the edge of the furrow and are connected together by a web, often extending to half their length in dry specimens and further in alcoholic ones. In alcoholic specimens all the spines are invested in a rather thick membrane. Each adambulacral plate bears, also, a transverse series of 4 or 5 spines of about the same length as, but somewhat thicker than, the furrow-series; they differ but little in length, but the outermost ones are slightly smaller than the inner ones.

The jaw-plates are large and broad; each pair jointly bears an inwardly directed group of 6 rather stout tapered spines, of which the 4 central ones are largest; each plate also bears a marginal row consisting of 7 or 8 somewhat smaller spines, the innermost ones being the largest; a curved row of 8 or 9 similar spines is borne on the central crest of each jaw plate; those of the 2 rows usually cross each other over the elliptical, naked, intermediate space.

Off Cape Cod, station 264, in 80 fathoms, 1879; off Nova Scotia, stations 85 and 86, 101 fathoms, 1877; also taken by the Gloucester fishermen on George's and Western Banks, in 45 to 80 fathoms.

This species is allied to *S. endeca*, but differs widely from that species

in the much longer and more numerous furrow-spines; in the larger and more evenly spined dorsal pseudopaxillæ; in the much smaller and more spinulated ventral areas; and in the shorter and broader jaw-plates and shorter mouth-spines.

SOLASTER BENEDICTI, new species.

Rays usually nine, moderately long, well-rounded, tapering rapidly to the narrow acute tip; rather high at base; in length about equal to the diameter of the disk; the lesser to the greater radii are as 1 to 2.75. Greatest diameter of the largest type specimen, 220 mm.; lesser radius 38–42 mm.; greater radius, 105–115 mm.; breadth of arms at base, 25 mm.; height of arms at base, 15 mm.; diameter of dorsal paxillæ, about 5 mm.; diameter of madreporic plate, 3 mm.; distance from the center of the madreporic plate to anus, 11 mm.; length of the crests of the marginal plates transversely, 3 mm.; height, including spinules, about 2 mm. Jaws broad, truncated, with four subequal oral spines and numerous small lateral spines.

The disk is thick, swollen, usually convex. The whole dorsal and lateral surfaces of the disk and arms are covered with small, well separated, conical pseudopaxillæ which bear a small group of tapering, acute, divergent spinules. The pseudopaxillæ on the central region of the disk are larger than elsewhere and bear about 5 to 7 spinules, of which 1 is central and sometimes longer than the others.

On the sides and towards the ends of the arms the pseudopaxillæ decrease regularly in size until they bear but one or two small spinules near the tips of the arms. On the sides of the arms they are arranged in quincunx and form regular oblique rows. On the dorsal surface they are arranged regularly, but do not form very distinct rows. The papulæ are rather small and mostly occur singly in each interspace between the plates, which are rather firm and form a closely reticulated skeleton. The madreporic plate is small, inconspicuous, partially concealed by several special pseudopaxillæ larger than the rest; it is situated decidedly nearer to the center than to the margin. Anal opening conspicuous, nearly central. The upper marginal plates are very small and bear pseudopaxillæ similar to, and only slightly larger than, those of the plates above them. Inferior marginal plates much larger, with a prominent, much compressed, transverse crest which bears a row of small conical spinules, of which there are 10 to 12 or more on the plates near the base of the arms, where they mostly form a single row, but on the distal portion of the arm, where the plates become thicker and more rounded, the spinules are shorter, stouter, and form two rows; the spinules near the lower margin of the plate are the longest; when well preserved these spinules usually taper to an acute tip. In the interradial angles the crests of the marginal plates become very thin, and the spinules are more slender, more numerous, and often form a single regular row. The actinal interradial areas are moderately

wide and closely covered with concealed plates, each of which bears, on a small conical elevation, one or two tapering acute spines, similar to, but smaller than, the adjacent adambulacral spines. A row of intermediate actinal plates extends out on the rays nearly to the tips, between the lateral and adambulacral plates; each of these usually bears a simple acute spine similar to the adjacent adambulacral spines. In younger specimens a similar row of plates and spines extends out a short distance along the ray. Each of the adambulacral plates bears an inner or furrow-group of 4 or 5 moderately long, rather stout, tapered, acute spines, of which the central ones are a little the longest; these spines are firmly united by a web for more than half their length in dry specimens, in some of which they closely interlock across the grooves. Each plate also bears a transverse row, usually of 3 moderately stout, much tapered, acute, usually somewhat curved spines. These are about equal in length and are longer than, and about twice as thick as, the furrow-spines.

This species was taken in 1885 at station 2530, off George's Bank, in 956 fathoms, one specimen (No. 14848, U. S. N. M.); at station 2550, off Martha's Vineyard, in 1,081 fathoms, one specimen (No. 11816, U. S. N. M.), and in 1886 at station 2682, off Martha's Vineyard, in 1,004 fathoms, three specimens.

CROSSASTER HELIANTHUS, new species.

Rays about 13, rather short, their length less than the diameter of the disk, rounded above, rapidly tapered. The proportion of the radii of the type specimen is as 1 to 2.10.

The greatest diameter is 125 mm.; the lesser radius, 30 mm.; the greater radius, 63 mm.; the diameter of the madreporic plate, 4 mm.; breadth of rays at base, 13 mm.; length of rays, 30 to 38 mm. The disk is large and swollen. The whole dorsal surface is covered with moderately large and somewhat elongated paxilliform prominences or pseudopaxillæ, which are rather regularly arranged and well separated, plainly showing in dry specimens the rather firm and closely reticulated skeleton and the small but well-defined interspaces, so that the surface has a rough appearance when dry. The skeleton plates are stoutest opposite the interradial angles on the disk. The pseudopaxillæ are the broad-based somewhat conical central summits of the plates; each of the larger ones bears a compact fascicle of 6 to 12 or more small somewhat elongated erect spinules, of which 2 or 3 in the middle of each group are a little the longest, causing the clusters to have a rounded apex. Toward the end of the arms the clusters of spinules are much smaller. The papulæ are small and very numerous, 6 to 9 usually occurring in each of the larger dorsal interspaces. Madreporic plate rather large, situated about midway between the center and margin, not surrounded by specially large pseudopaxillæ.

The inferior marginal plates are prominent, well spaced, not very numerous, about 16 to 18 in the type specimen. Those near the base

of the ray are transversely oblong, with a curved summit, and bear 20 to 30 small slender spinules mostly arranged in 2 rows; the upper ones are smallest and similar to those of the dorsal pseudopaxillæ. Beyond the middle of the ray the marginal plates become short and bear an irregular group of crowded paxillary spinules. The upper marginal plates are small and bear paxilliform groups scarcely different from those of the dorsal surface of the rays; on most of the rays there is an irregular row of small pseudopaxillæ just below the inferior marginal plates, but usually terminating before reaching the end of the ray.

Actinal interradial spaces narrow, elongated, and covered with a thick skin which is radially striated and bears small scattered fascicles of 2 to 6 rather long, slender, paxillary spinules, while some similar spinules stand singly, leaving much of the surface bare. The adambulacral plates are crowded and each bears a furrow-group of 3 or 4 rather long, tapering, acute spinules, which stand in a somewhat curved row, the central one being larger and somewhat farther inward than the others; outside of these, each plate bears a transverse row of about 10 to 12 closely placed spines, similar in size to the furrow-spines; some of these spines are forked at the tip, others are obtuse, but most are acute, and the outermost are somewhat smaller and more slender than the others. In alcoholic specimens these spines, as well as all the furrow-spines, are united by a web. The jaw-plates are narrow and elongated; each bears 4 large, inwardly directed terminal spines, of which the 2 central are decidedly larger and longer than the others, and also a row of smaller acute spines on each side. The ventral surface of each jaw forms a sharp, elongated carina inclosing a narrow elliptical space. On each carina there are about 10 to 12 slender elongated spines.

This species appears to be a true *Crossaster*, but differs widely from *C. papposus* in the stouter and closer skeleton plates, smaller and more numerous dorsal pseudopaxillæ, with much shorter spinules, and in the much more numerous and shorter adambulacral spines.

It was taken in 1880 by the Gloucester fishermen, near George's Bank, in deep water (schooner *Martha C. Young*.)

Family PTERASTERIDÆ, Perrier.

PTERASTER (TEMNASTER) HEXACTIS, new species.

Disk broad, very high, evenly convex, with a rather large central opening surrounded by circles of prominent, imbricated, and webbed spines. Rays six, short, broad, tapered to blunt tips, their lateral margins convex. Lesser to greater radii, about as 1 to 1.5. Lesser radii, 22 mm.; greater radii, 32 to 35 mm., in the alcoholic specimen; height of disk, 30 mm.

The surface of the disk is covered with very numerous small spinules, covered more or less completely with a thick skin-like membrane and arranged in irregular, divergent groups.

The integument between the spinules is thick, smooth, firm, and everywhere perforated by numerous very small, round pores.

In each interradial region there is a narrow, radiating groove, lined with thick naked integument, destitute both of spinules and pores, but showing a wrinkled surface. These grooves commence at about one-fourth the distance from the dorsal center to the margin. In some cases there is only a small slit-like opening in the upper end of the groove, communicating with the space beneath the dorsal membrane, but in some of the interradii the slit is much larger and longer, reaching nearly or quite to the margin, and communicates with a large marsupial pouch, containing well-formed young, some of which were in the act of escaping when preserved. Apparently the slit-like openings are formed, or at least much enlarged, when the young are ready to come forth, and after their birth the edges of the slits may become again united.

The dorsal spines or pseudopaxillæ beneath the integument are large, stout, rather long, and surmounted with a large divergent group of long, slender spinules. In the interradial region, within the marsupial pouch, there is a group of several lobed or branched papulæ at the base of each paxilliform spine. The large spines situated along each side, within these cavities, have rudimentary spinules at the summit, which do not reach the outer membrane so that they stand free within the cavity, thus leaving the membrane unsupported along the slits. On the ventral side the rays are nearly flat, and the disk around the mouth is deeply concave.

Each ray is broadest at the margin of the disk. The transverse combs are numerous and covered with a thick, firm skin, which entirely conceals the spines in alcoholic specimens. On the broadest part of the ray, opposite the margin of the disk, there are mostly four, rarely five, spines of moderate length in each comb; of these the one next the groove is somewhat shorter than the two or three which succeed it, while the outermost is still shorter and directed more outward, so that the group has a somewhat rounded, but not very elevated, scolloped margin, the membrane receding somewhat between the points of the spines. The spines, when exposed, are rather slender, flattened, rough, and truncate at the flat tip; beyond the outer spine the web rapidly becomes less elevated and each comb lies somewhat obliquely over the one next beyond it, and becomes only a slightly elevated broad fold before reaching the margin. These folds entirely conceal the transverse, ventral spines, which extend to the margin of the ray, but project beyond it very little, if at all, so that the margin is only crenulate or separated into small blunt lobes, separated by slight notches.

Between the outer ends of the combs of webbed spines there is a small, oval pore, which is sometimes covered by an oval operculum, but in some cases it gives exit to a group of two or three short, blunt papuliform organs.

The jaws are surrounded by a marginal group of long, slender, webbed spines, of which there are about four or five on each side; the two innermost are somewhat the largest; on the actinal side of the jaws there are also two much larger, isolated spines, one on each plate; these are entirely covered by a thick skin; when this is removed the spine is flattened, tapered, and blunt at the tip, with a rough surface, but not hyaline.

The ambulacral feet are large and in two regular rows.

Color of the alcoholic specimen dull purple above, darkest on the central part of the disk and interradial region; beneath yellowish.

Taken at station 2433, off Newfoundland Bank, N. lat. 43° 05′, W. long. 50° 43′, in 57 fathoms; one specimen (No. 12004, U. S. N. M.).

This species not only differs from other known forms in having six rays, but appears to be peculiar in the presence of naked interradial grooves and genital slits. This last character may be sufficient to warrant its separation as a distinct subgenus (*Temnaster*, Verrill), or even as a genus. It differs from our other species also in having fewer and stouter spines in the ventral combs; in the broader and flatter ventral surface of the shorter rays; in the much thicker skin of the ventral combs, and in the less evident comb of spines along the margins of the rays. The dorsal membrane is also firmer and not at all granular; the spinules over its surface are much more numerous, and the pores between them are smaller and more numerous.

The several young ones taken from the interradial slits all have six rays, rendering it probable that this is the normal number.

HYMENASTER MODESTUS, Verrill.

Hymenaster modestus, VERRILL, Amer. Journ. Science, XXIX, p. 151, 1885.

Body small, pentagonal, with concave borders, rays short, broad, subacute. The dorsal membrane is thin, translucent, with minute granule-like specks; the spiracular pores are few and minute; the dorsal cavity, beneath the membrane, is relatively large. Each adambulacral plate bears three very slender, acute, rough spines; two are placed obliquely at the inner edge, and of these the distal is usually much shorter than the other; the third, which is external to the others, but close to them, on the actinal side of the plate, is more erect, longer, and slightly larger; on the middle part of the rays there are often two similar spines on the actinal side of the plate, close together.

The actinal radial spines are very slender, not crowded, 16 to 18 on each side; the longest ones are the fifth and sixth; these and those beyond reach the margin, which is scalloped between them. The pores between the inner ends of the actinal rays are round, and protected by an opercular spine or papilla, which is flat and expanded at the base, but thin and slender at the tip. The dorsal pseudopaxillæ are rather large and few in number, with long terminal spinelets, which project through the dorsal membrane as small spinelets; they are pretty uniformly distributed, and there are no defined radial areas.

The jaws have a salient inner angle and an elevated actinal prominence, on which there is, on each plate, a small, short spine near the inner end (others may have existed, but, if so, were rubbed off in the dredge); on each side of the jaw there is a marginal series of about five slender spines.

Color, in alcohol, pale buff above, pink beneath.

Greater radius, 10 mm.; lesser radius, 7 mm.

Stations 2052 and 2096, in 1,098 and 1,451 fathoms, 1883.

Family ECHINASTERIDÆ, Verrill.

CRIBRELLA PECTINATA, new species

Rays five, elongated, rounded, thick at base, tapering evenly to the small tips. Disk moderately swollen, the lesser to the greater radii as 1:4.4.

The lesser radius of the type-specimen is 15 mm.; the greater radius, 66 mm.; breadth of rays at base, 18 mm.; diameter of madreporic plate, 3 mm.

The whole dorsal surface and sides of the rays are evenly covered with small well-spaced pseudopaxillæ, each of which bears a fascicle, or more rarely a comb-shaped group of four to eight or more small slender spinules, which stand nearly erect, and are nearly equal in length. The pseudopaxillæ arise from elevations of the plates and are so spaced as to leave intervals greater than their own diameters, thus giving the surface a rough papillose appearance; the pseudopaxillæ are more closely arranged on the center of the disk than on the arms. The madreporic plate is large and covered with rough spinules in comb-like groups.

Each of the interspaces on the arms bears a single large papula, equal in diameter to or exceeding the pseudopaxillæ; similar papulæ occur between the ventral plates, where they form regular longitudinal rows. On the ventral surface of the rays there are three regular longitudinal series of plates corresponding in number to the adambulacral plates. The plates in the two outermost rows are oblong at the summit, and each bears an oblong group of slender paxilliform spinules, arranged in two rows, and similar to those of the back. The plates of the outer row are somewhat smaller than those of the next, and the spinules are about twelve to fifteen in number toward the base of the rays, while in the next series there are from twenty to twenty-five spinules, which form pretty regular comb-like groups; these extend to the tips of the arms. Each of the interspaces between these rows of plates (which probably represent marginal plates) contains a single large papula. Closely adjacent to the adambulacral plates there is a row of smaller plates, each of which bears a round group of small paxilliform spinules, ten to fifteen in number, similar in size and form to those of the marginal plates. This row of intermediate plates extends from the angle of

the jaw nearly to the tips of the arms, and is not separated from the adambulacral plates, with which they correspond in number, by any papulæ.

Each of the adambulacral plates bears a single small spine, situated deep within and directly across the furrow, forming a single longitudinal series, and also a transverse group, consisting of eight to twelve round, blunt spinules, in two rows; the three inner ones are decidedly longer and larger than the rest, the innermost odd one being the largest of the three, and standing erect on the extreme inner angle of the plate, and therefore nearly at right angles to the small spine within the furrow. The outermost spinules of these groups are similar in size to those of the adjacent ventral plates, from which they are separated by a distinct continuous groove. The jaws are covered with numerous erect spines, which are similar in size and form to those of the adambulacral plates, but the adambulacral plate nearest the mouth bears a group of small blunt spinules deep within the furrow.

Eastport, Me., in shallow water, 1870. (A. E. Verrill.)

This species is similar to *C. sanguinolenta* in form and general appearance, though the dorsal surface is more uneven and papillose, owing to the larger size of the pseudopaxillæ and the more regular interspaces; the pseudopaxillæ are generally more in the form of rounded fascicles, instead of regular comb-like groups. The differences are much more marked on the ventral surfaces, where the three regular rows of larger ventral plates give a very different appearance to this region, for in the former species the plates are scarcely distinguishable in size, form, and spinulation from those of the lateral and dorsal plates of the rays. The adambulacral and jaw-spines are also shorter and more crowded than in the common form; the papulæ are more regularly arranged and not so numerous.

Family ASTERIIDÆ, Gray, 1840 (emended).

HYDRASTERIAS OPHIDION, Sladen.

Asterias (Hydrasterias) ophidion, SLADEN, Voyage of the Challenger, XXX, p. 581, pl. 99, figs. 3 and 4; pl. 103, figs. 3 and 4, 1889.

A broken specimen was found at station 2573, in 1,742 fathoms. Its structural characters appear to me to be worthy of generic rank.

Family BRISINGIDÆ, Sars.

ODINIA AMERICANA, Verrill.

Brisinga americana, Verrill, Amer. Journ. Sci., XIX, p. 139, 1880; Rep. Com'r. Fish and Fisheries, XI, p. 636, pl. 17, fig. 52, 1885.

Freyella americana, SLADEN, Voyage of the Challenger, XXX, pp. 616, 617, 834, 1889.

This large species is furnished with an abundance of long papulæ on the swollen genital region of the rays, as stated in the original description. It belongs, therefore, to the genus *Odinia*. It is not easy to un-

derstand why Sladen should have referred it to *Freyella*, unless by inadvertence.

BRISINGA COSTATA, Verrill.

Brisinga costata, VERRILL, Amer. Journ. Sci., XXVIII, p. 382, 1884.

The original type from station 2210, in 991 fathoms, has the following characters:

The disk is firm, round, roughly spinulose, the spines small, sharp, standing singly or in groups of two, three, or more. Interradial plates nearly concealed, the exposed part verruciform. Madreporic plate moderate, with many radiating gyri. Arms very long, strongly depressed, somewhat swollen toward the base, but broad and angular and carinated farther out, gradually tapering. The basal portion is crossed by 20 to 25 curved or sinuous, very prominent, strong, narrow ribs, or carinæ, some continuous and some interrupted, and surmounted by a simple row of small, short, acute spinules. Smaller transverse raised bands of pedicellariæ and small spinules alternate with the ribs. The adambulacral plates bear usually three, or alternately two and three, slender, fluted, glassy spines in a transverse row at about the middle of the plate. The two actinal ones are longer and larger than the other, which is small, nearly erect, and situated on the proximal angle. In addition to these there is a smaller, more slender, inner furrow-spine, situated at the distal end of each plate and projecting horizontally more than half-way across the groove. Sometimes on alternate plates there are two of these transverse spines toward the base of the arms. The outermost large spine on alternate segments stands raised on a tubercle on a separate lateral plate, which appears to become consolidated with the adambulacral plate on the distal half of the ray. The alternate lateral plates are elongated, radially narrow-oblong, spineless, and in contact with the adambulacral plates. These lateral plates agree nearly with the adambulacral in number, but not in length. All the spines are sharp and bear swollen sheaths covered with minute pedicellariæ.

The jaws bear, on each half, a slender transverse spine on the inner angle and a large one on the outer angle; sometimes the two outer ones are consolidated into a single larger median one. The adoral end is often without spines, but sometimes bears one small spine on each half or one on one side directed orally. The lips close to the mouth are slightly verrucose.

Diameter of disk, 28 mm.; breadth of arms, near base, 11 mm.; length of longest spines, 12 mm.

Station 2210, in 991 fathoms (No. 7820, U. S. N. M.). It was also taken at station 2533, in 828 fathoms, and at station 2734, in 841 fathoms, a single specimen at each locality.

BRISINGA MULTICOSTATA, new species.

Rays 15 in the type specimen. Disk 27 mm. in diameter when dried; round, flat, densely covered with small, rounded, convex plates,

which are in contact or somewhat imbricated over the greater part of the surface and have a small conical elevation in the middle, upon which there is generally 1, but sometimes 2 or 3, small, slender, very acute spines of nearly uniform size over the entire surface, except at the origin of the rays, where both plates and spines are smaller. The madreporic plate is small, situated close to the margin, and has prominent radiating gyri.

Between the bases of all the arms and standing obliquely on the margin there is a rather large, oval, interradial plate, with the surface concave and bare of spines, except around the margin, which is more or less encroached upon by small spinous disk-plates. On the central part of each interradial plate there is a small group of pedicellariæ having very slender, curved jaws. A few similar pedicellariæ occur scattered on the disk between the spines. Opposite the base of each ray, near the margin of the disk, there is a pair of small pores each in the middle of a small naked membrane.

The jaw-plates are narrow and elongated, the two together being somewhat hour-glass shaped. Each jaw usually bears a pair of very slender, sharp spines on the oral edge, directed inward; sometimes there is also a much larger median spine in the same plane; on the extreme inner angle on each side there is also a very small, slender spine directed transversely, but the relative size and even the number of these spines varies on the different jaws of the same specimen; on the outer end each jaw bears a pair of much larger lateral spines which stand more erect; sometimes an additional smaller spine occurs just below one or both of these. On some of the jaws an additional large lateral spine is occasionally found at about the middle and near the margin of one plate and occasionally a pair of such spines appears. All the jaw-spines are covered with groups and clusters of pedicellariæ, and the larger spines are inclosed in a sacculated membrane.

The rays are very long, rather large; in the basal-genital region the ray is somewhat swollen and evenly convex, but is here broader than high in the dry specimen; farther out the rays gradually become slender and angular, with a strong dorsal carina due to the ambulacral plates beneath the thin membranous integument. The genital region is usually prolonged and is crossed by a very large number of considerably elevated, thin, acute, transverse ribs or carinæ, composed of conical and oblong elevated plates, and surmounted by a simple row of numerous very slender, sharp spines, mostly arranged in comb-like groups along the crest of the plates. In a well-grown specimen there are on some of the rays upwards of 60 transverse ridges, besides a number of irregular ones at the proximal and distal portion. The ridges, however, are not very regular, many of them being crooked and more or less interrupted, while a very few extend entirely across the ray, and the number varies considerably on different rays. Where best developed these ribs are alternately larger and smaller; the larger ones cor-

respond with and are opposite to the adambulacral plates and have a large lateral spine at their origin on each side; the smaller ribs are irregularly interpolated between the larger, but have the same kind of plates and spinules, but have no large lateral spines; close to the base of the ray the plates are often irregularly scattered on the dorsal surface and form imperfect rows only on the sides. The number and closeness of the transverse ribs varies on different arms of the same specimen, but in all cases they are more numerous (45 to 60) and closer together than is usual in the genus. A series of round brownish spots, alternating with the larger transverse ribs on each side, apparently indicate the position of the genital pores.

In contact with the adambulacral plates there is a row of small, alternately unequal, lateral plates, two of them corresponding to each adambulacral plate. Toward the base of the rays these plates are about as broad as long, but distally they become narrower and more oblong and much smaller. On the tumid part of the ray, except close to the base, those lateral plates nearly opposite the middle of the adambulacral plates are elevated, and have a central tubercle, bearing a long, slender, strongly fluted, acute spine similar to the outer ones of the adambulacral plates; toward the extreme basal part of the ray these lateral spines decrease in size, until on the first 4 or 5 segments they are nearly abortive. The long lateral spines continue on the distal part of the ray, but the lateral plates which bear them often become consolidated with the adambulacral plates. The alternate lateral plates are flat and bear no spines.

The adambulacral plates are numerous and short, excavated at the middle of the inner margin. On the middle of the swollen reproductive region each plate may bear as many as 5 or 6 spines; of these, 2, forming the transverse furrow-series, are very slender and situated 1 at either end of the inner margin of the plate extending more than half way across the furrow; another slender spine of similar size often stands above each of these, but one or both of these may be absent, on alternate plates, especially on the more distal part of the ray. On the actinal side, and at about the middle of each plate, there are 2 much larger and longer spines, one external to the other, the outer one being considerably larger and longer than the inner, its length being equal to the breadth of the ray; these two, with the similar lateral ones, form an oblique transverse row. Close to the basal part of the ray, the two outermost of the adambulacral spines become much stouter and are columnar in form; the tip becomes swollen with a truncate or convex papillose summit. The apical papillæ apparently correspond to the terminations of the lateral flutings.

The transverse spines within the furrows bear, sometimes singly and some times in clusters, more or less numerous rather large pedicellariæ with very slender, strongly curved jaws. Similar pedicellariæ occur between the larger spines on the adambulacral plates. The larger

spines, in alcoholic specimens, are covered with a loose sacculated integument, which is densely covered with minute, crossed pedicellariæ. The ambulacral feet are large with well developed terminal suckers; each one is usually separated from the next in the same row by two transverse furrow-spines, but frequently only one of these is developed.

A good sized specimen in alcohol has the radius of the disk, 14 mm.; length of the longest remaining ray, which is broken at some distance from end, 220 mm.; breadth of the rays at base, 6 mm.; at the widest part, 8 mm.; length of the disk-spines, 1 to 1.5 mm.; length of longest arm-spines, 14 mm.

Taken in 1885, at station 2573, off George's Bank, in 1,742 fathoms, 3 specimens (No. 12074, U. S. N. M.); also in 1886, at station 2685, off Martha's Vineyard, in 1,137 fathoms, 1 specimen (No. 14858, U. S. N. M.).

BRISINGA VERTICILLATA, Sladen.

Brisinga verticillata, SLADEN, Voyage of the Challenger, XXX, p. 604, pl. 109, figs. 9–11, 1889.

A number of disks and loose arms have been taken off our coast, from N. lat. 41° 13′, W. long. 66° 50″, to N. lat. 36° 34′, W. long. 73° 48′, in 906 to 1,374 fathoms.

FREYELLA ELEGANS (Verrill) Sladen.

Brisinga elegans, VERRILL, Amer. Journ. Science, XXVIII, p. 382, 1884.

Freyella bractiata, SLADEN, Voyage of the Challenger, XXX, p. 629, pl. 114, figs. 1–4, 1889.

Rays nine to fourteen, but in the majority of specimens twelve, very long and slender, with the reproductive region considerably prolonged and only slightly swollen. Radii as 1 to 36+. Diameter of the disk of a large specimen, about 25 mm. Disk small with rather acute interradial notches. The surface is densely covered with small, unequal, somewhat imbricated plates, most of which are rounded in outline, while others are angular; all have an elevated, conical, central tubercle, and bear from one to three, or four, small sharp spines, much the greater number having only one spine. Madreporic plate close to the margin, prominent, with few deep grooves separated by broad ridges. Interradial plates not distinct, dorsal pore nearly central, usually very distinct and surrounded by a group of small spinules, borne on small angular plates somewhat smaller than those on the rest of the disk. The spinules of the disk are numerous and uniform in size, so that it appears to the naked eye rather closely and evenly spinulated. Numerous small, delicate pedicellariæ are usually scattered over the disk between the spines and around their bases, but in some specimens these are mostly wanting. The peristome is very large and the buccal membrane is smooth and delicate. The jaws are rather narrow, longer than broad, with prominent inner and outer angles with incurved sides and a distinct median suture; each half bears two transversely directed spines, one at the extreme inner and the other at the outer angle of the furrow;

the inner end usually bears also a pair of very slender, acute spines directed orally, one on each plate, but sometimes some of the jaws have three or four inner spines, and sometimes but one, in the same specimen; each half of the jaws also bears a much larger and longer spine on the actinal surface at the extreme outer end, corresponding in size and position with the adjacent adambulacral spines. All the mouth-spines are covered with membranous sheaths, often sacculated, and bearing large numbers of minute pedicellariæ, among which are some of much larger size with strongly curved jaws.

The slightly tumid genital region of the rays extends about one-fourth the total length; this portion is evenly rounded on the upper surface and densely covered with angular imbricated scales, each of which usually bears a transverse group of small, sharp spinules, similar to those on the disk (the number varies from one or two to six or eight); they frequently form comb-like clusters on the sides of the arms, where they are most numerous. In some of the larger specimens some of the large plates on the sides of the arms bear, here and there, a single spine three or four times as large as usual. Beyond the genital region the ray is somewhat triangular, with a strong bilobed dorsal carina due to the ambulacral plates showing through the thin dorsal membrane. The rays taper very gradually to a long attenuated distal portion. The carinated portion of the ray is crossed by broad bands of minute pedicellariæ corresponding with each adambulacral plate. The ray terminates with a rather conspicuous plate at least twice as wide as the ray near it; seen from above it has an obovate form swollen in the middle and bilobed on the proximal end; on the rounded aboral end there are six long, slender spines, of which the two median ones are smallest and the lateral ones as long as, or longer than, the length of the plate; at the extreme outer end of the plate there is a projection beneath which the eye is situated.

The adambulacral plates are numerous, rather short, and narrow; the furrow side is strongly concave in the middle opposite the suckers, and the distal angle is narrow and prolonged so as to touch or slightly overlap the proximal angle of the succeeding plate. The sutures between the plates are rather wide and moderately oblique. Toward the base of the rays, in the larger specimens, each plate usually bears a single, long, transverse spine on its distal angle; these spines, extending more than half across the groove and overlapping the spine of the opposite side, serve to separate the pairs of suckers. Along the thickest part of the ray some of these plates have two similar transverse spines, one just above the other, but the extra spine seldom occurs on the smaller specimens. On the prominent actinal surface each plate bears a much larger, long, slender, acute, strongly fluted spine; back of this there is another row of similar large spines one-half as numerous, which often appear to stand on the outer distal angle of the adambulacral plate, but on certain parts of the ray the small

plate which bears them is distinct, and may be recognized to belong to a separate series of small lateral plates which lie in contact with the outer edge of the adambulacral plates and between which there are, alternately, one or two small plates without spines; close to the base of the rays these lateral spines are entirely obsolete. On the distal half of the ray the plate bearing the lateral spines is usually consolidated with the distal end of the adambulacral plate. Owing to this arrangement the adambulacral plates appear to bear, alternately, one or two long actinal spines on prominent basal tubercles. The longer spines on the distal part of the rays are often as long as three or four adjacent arm-segments; on the basal part they are usually equal to about two arm-segments. All the large spines are covered with sacculated integument which is completely covered with minute pedicellariæ. The furrow-spines bear clusters of somewhat larger pedicellariæ near their tips.

A rather large, dry specimen has the radius of the disk, 12 mm.; length of the longest ray, which is broken at the end, 200 mm.; breadth of ray at base, 5 mm.; at the widest portion, 7 mm.; height, 7 mm.; length of dorsal spines, about 1 mm. Another dry specimen has the radius of the disk, 9 mm.; length of the longest ray, which is broken at some distance from the end, 175 mm.; greatest breadth of ray, 5 mm.; length of the longest spines, 6 to 7 mm.

Taken at several stations in 1,374 to 1,434 fathoms.

FREYELLA ASPERA, new species.

Rays, thirteen. Diameter of the disk, when dried, 20 mm. The dorsal surface of the disk is covered with rather large, irregular, often rounded, somewhat thickened plates, which are imbricated on the central portion of the disk, but separated more or less by naked integument toward the margin, and imbricated immediately around the margin. Each plate bears a group of ratner stout, conical, acute, divergent spines about 15 to 20 mm. long; they often form somewhat stellate groups, but in other cases stand in one or two transverse rows. Each plate usually bears from three to eight spines and also some rather large crossed pedicellariæ, with slender, strongly curved jaws. The dorsal pore is subcentral and surrounded by a group of spines a little larger than those over the rest of the disk. Madreporic plate, small, prominent, with a few rather wide, deep, convoluted grooves.

The jaws are short and wide, about as broad as long, with prominent inner angles and somewhat incurved lateral margins. Each jaw normally bears six spines at the adoral end; usually there are four of these, arising from the inner edge and directed inward, which are small, rather slender, and subequal, their length being equal to about one-half the width of the jaw; each inner angle bears a larger, rather short, robust spine, which projects obliquely about half way across the furrow; each outer angle bears a rather long robust spine on the actinal surface;

on some of the jaws there is a similar spine on the middle of each lateral margin, but these are more frequently absent. Some of the jaws also vary in the same specimen by having only two small spines on the inner edge; others have three.

All the jaw-spines are covered with loose membrane, which bears clusters of numerous pedicellariæ, those on the longer actinal spines being very minute, while those on the oral spines are much larger, with slender, strongly curved jaws.

All the arms are broken off in our type specimen, only the three basal segments remaining on any of them; on these segments each adambulacral plate bears a slender, transverse furrow-spine on the prominent distal angle of the margin, and a rather long, slender, acute, fluted spine on its actinal surface; the latter are covered with minute pedicellariæ, while the transverse furrow-spines carry clusters of large pedicellariæ like those of the oral spines.

The dorsal plates of the bases of the arms, so far as preserved, are similar to those of the disk, but rather smaller, and carry similar, but smaller, spines in small groups.

Taken in 1883 at station 2097, off Chesapeake Bay, in 1,917 fathoms (No. 6301, U. S. N. M.).

This species resembles the coarser spined variety of *Brisinga multicostata* in the spinulation of the disk, but the jaws are much broader and their spines quite different.

FREYELLA MICROSPINA, new species.

Rays in the type specimen, thirteen, slender, and of moderate length, evenly rounded and a little swollen on the genital region, angular and slender beyond. Radii, about as 1 to 10. Dorsal surface of the disk is thickly covered with small, rounded plates, each of which bears a cluster of numerous very minute spinules in more or less stellate groups, mostly of six to twelve. Interradial plates indistinct or showing but little of the surface. Jaws very short and broad, the breadth about equal to the length; the oral end usually bears six small divergent spines, three on each half, but sometimes only four or five are developed; of these the two outermost, situated on the angles, are directed nearly transversely and are usually blunt or bilobed at the end; the other four, which are directed orally, are smaller, the two central ones very small and papilliform. The actinal surface of the jaw usually bears a pair of rather short, robust spines situated on the somewhat prominent outer angles; these spines are more or less clavate and often flattened at the end, which is usually divided into two to four short prongs or papillæ, and in some cases it is deeply fissured; they agree nearly in size and structure with the succeeding spines on several of the basal adambulacral plates.

The genital region of the ray occupies rather more than one-fourth the total length, and is considerably swollen on the upper side, so that

the height, where best developed, is greater than the breadth. The dorsal surface of this portion is completely covered by flat, imbricated, rounded, and angular plates, each of which bears a large number of very minute, sharp, conical spinules, which are closely arranged over most of the surface, but on the sides of the rays they often form two or three small transverse rows on each plate. With these spinules on the plates there are also many minute pedicellariæ.

Low down on the sides of the rays, and especially on the distal portion of the genital region, the plates form regular transverse series or bands with naked integument between them; each of these bands corresponds with one of the adambulacral plates. The last of the bands are imperfect, or represented by only a few plates on the dorsal surface, and cease entirely opposite about the twenty-fifth adambulacral plate. On the distal part of the arm the thin membrane is crossed by a broad band of minute pedicellariæ, a band corresponding to each adambulacral plate. Apical plate not much enlarged, short, obovate, obliquely truncate at the end, about as long as broad; its spines have been rubbed off from the only one preserved.

Along each side of the ray there is a row of long, slender, lateral spines apparently arising from small tubercular marginal plates, which are mostly coalescent with the outer end of the adambulacral plates and usually might be described as a part of them. These marginal spines, on the distal part of the rays, occur opposite the alternate adambulacral plates, but along the genital region they occur only opposite every third plate.

The adambulacral plates are somewhat longer than broad, except at the base of the ray, and but little emarginate on the furrow-margin. Each plate bears a long, slender, fluted spine on the actinal surface, similar to the adjacent marginal spines, and on alternate plates there is usually a much smaller, acute, more or less inclined furrow-spine standing just in front of the larger one, but these are mostly absent or rudimentary on the distal half of the ray. There are no transverse furrow spines, unless the spines just described be considered as such. On nine or ten of the basal adambulacral plates the large actinal spine is stout and columnar, with swollen or clavate tips, concave on the summit, and bearing about four to eight blunt papillæ around the margin; those nearest the base are shortest and stoutest, the length increasing and the size of the terminal enlargement decreasing gradually on those farther out.

Radius of disk, 10 mm.; of longest rays (which may have been regenerated), 95 mm.; length of longest spines, 8 mm.

Taken in 1884, at station 2220, off Martha's Vineyard, in 1,054 fathoms, one specimen (No. 7821, U. S. N. M.).

This peculiar species, in having a more or less distinctly banded arrangement of the plates on the genital region of the rays, approaches the restricted genus *Brisinga*, but its affinities are decidedly with

Freyella in other respects. The stout, clavate or mushroom-shaped spines at the base of the arms are similar to those of *Brisinga multicostata*, but the end is concave and the papillæ of the terminal crown are fewer and larger. In the absence or rudimentary condition of the transverse furrow-spines it differs from most of our other species, as well as in the minuteness and great number of the dorsal spines of the disk and rays.

OPHIUROIDEA.

Family OPHIURIDÆ.

OPHIOGLYPHA SAURURA, new species.

A five-rayed species with very convex, angular, unequal disk-scales and radial shields, the latter with prominent outer ends nearly or quite in contact. Arms high and somewhat carinate, each dorsal plate with a central and distal prominence, thus appearing serrate in profile. Three short arm spines. Mouth-shield broad, shield-shaped, pointed within. Mouth-papillæ numerous, regular, pointed. Arm-comb absent or rudimentary.

Diameter of the disk, 17 to 18 mm.; length of arms (broken at tip), somewhat more than 40 mm.; breadth of arms at base, 3 mm.; height, 3.5 mm.

Disk flattish, moderately thick, pentagonal, with prominent corners and a small angular notch at the base of the arms. The disk-scales are very irregular in size and form, imbricated and mostly angular, with a prominent central or distal conical or rounded elevation on each.

The primary plates are only slightly larger than many of the others; the central plate is round and easily distinguished. In each interbrachial space there are four or five plates somewhat larger than those on the central part of the disk—one in the center of the margin is the most conspicuous; radial shields irregularly triangular, longer than broad, with the inner ends acute and widely divergent, the outer ends and sides obliquely rounded. The surface at the distal end rises into a conical or rounded prominence. In some cases the distal ends are in contact or slightly overlap one another. The divergent proximal ends are separated by four or five angular plates, of which one or two are large and prominent. The arm-comb appears to be entirely wanting.

Mouth-shields rather large, thick, convex, broad, shield-shaped; length, 3.5 mm.; breadth, 4 mm.; the outer margin is slightly rounded or subtruncate; the outer angles rounded; sides nearly straight, and the proximal edges straight or slightly incurved, forming an obtuse inner angle. The side mouth-shields are elongated, narrow, curved, with the inner ends somewhat spatulate. The interbrachial areas beneath are covered with convex, thick, angular plates similar to those of the back, but more regular; of these there are about twenty-four in each area, besides small ones in the angles between them. Mouth-papillæ are numerous, regular, closely arranged, acute, conical, with two at the angle of the jaw a little longer than the rest.

The genital slits are long and large, bordered along their distal portions by a long conspicuous genital plate. The papillæ are minute and granule-like along the proximal part of the slit, but become larger, flattened, and squarish at the distal end, where they are about two-thirds as long as the upper arm-spines.

The papillæ around the first tentacle pores are a little larger and blunt; of these there are from six to eight to each pore. The second pair of pores have four or five much smaller papillæ on each side. The third and fourth have about four. The next two have about three on each side; then, on about three or four joints, there are about two or three on the inner side; beyond that, only one.

The arms are of moderate length, regularly tapered, angular, higher than broad, with a more or less evident dorsal carina. In the typical specimens the dorsal plates are very much thickened and prominent; each one is crossed by one, or sometimes two, deep transverse grooves, so that the upper surface is divided into two, and sometimes three, elevations, of which the distal one is the most marked and forms the outer margin of the plate; the other one forms a more or less irregular central prominence which at the base of the arms forms a blunt transverse ridge, but farther out it becomes a rounded or ovate elevation of the median portion only. In the largest specimen the prominence at the base of the arms is divided into two by a secondary transverse groove; seen from above the dorsal plates, near the base of the arms, have a more or less regular hexagonal outline. The first seven plates are broader than long; the next six or seven are more regularly hexagonal; farther out they become more and more elongated, until the length becomes nearly double the breadth. The side arm-plates are thick with prominent distal margins. The arm-spines, which are three (rarely four) toward the base of the arms, are small, short, papilliform, nearly equally spaced, though the upper one is often somewhat removed; they are not more than one-fourth as long as the side arm-plates. In one specimen there are regularly four arm-spines on about three arm-joints near the edge of the disk. The first under arm-plate is pretty regularly pentagonal, about as broad as long; the second and third are larger, longer than broad, with the outer end broadest and the outer margin curved; beyond this the plates become broader than long, with the outer margin strongly curved and the sides slightly convergent; beyond the middle of the arm the form becomes transversely elliptical. Beyond the fifth or sixth under arm-plates the lateral plates meet beneath, and they become relatively longer in proportion as they approach the tips of the arms.

Variations.—A specimen from station 2528, of somewhat smaller size, having the diameter of the disk 14 mm., differs slightly from the type specimens. The disk scales are more rounded and evenly convex and the characteristic elevations on the dorsal arm-plates are much less conspicuous, owing to the transverse groove being broad and shallow,

nevertheless the entire margin of each plate rises into a very evident transverse ridge, very much as in the typical specimens. The arm-spines are a little larger and longer, about one-third as long as the side arm-plates near the base of the arms. The mouth-shields are also relatively broader and shorter, though they preserve the same general form. The scales on the ventral interbrachial areas are more numerous, smaller, and more equal, there being about forty of the larger ones.

Station 2429, south of Grand Bank, in 471 fathoms (No. 11500, U. S. N. M.,) two specimens; station 2528, off George's Bank, in 677 fathoms (No. 11499, U. S. N. M..), one specimen, 1885.

OPHIOGLYPHA TESSELLATA, new species.

A large species allied to *O. confragosa* Lyman. Disk pentagonal, with small notches at the bases of the arms, and without any distinct arm-comb. Radial shields irregularly ovate, or subtriangular, well separated. The rest of the disk is covered with pavement-like scales, irregular in size and form, among which the primary plates can usually be distinguished. A large plate lies in the center of the interbrachial margin. Mouth-shields pentagonal, bordered distally by another plate nearly as large.

Arm-spines, generally three, papilliform, very small and slender, the upper one widely removed from the others. Tentacles apparently confined to a few of the basal joints of the arms. Arms somewhat thickened at the base, with swollen joints, rounded above and regularly tapered, appearing rather rigid.

The disk is flattened or moderately swollen, with the interradial margins slightly curved or nearly straight. In young specimens, 6 to 8 mm. in diameter, the primary plates form a pretty regular rosette, and the large marginal interradial plates are in contact with the radial shields at each end; the radial shields are separated by a wedge of three plates in a single row.

In the largest specimens, which are about 22 mm. in diameter, with the arms about 65 mm. long, the disk-plates are much more numerous and irregular; the primary plates are rounded, about 1.75 to 2 mm. in diameter, but most of the intervening plates are angular, many of them appearing as if broken, with very small, irregular ones between the larger ones. The disk-plates are slightly thickened, but nearly flat, separated by narrow, rather deep grooves, in which the membrane appears wrinkled. In alcoholic specimens, the disk-scales are more or less obscured by a thin skin. The radial shields are about 4 mm. long and nearly as broad; their inner ends are divergent and form a somewhat acute angle; they are separated by six to eight scales, of which two or three are largest, and by two or three inner dorsal arm-plates. The large median interradial plate occupies most of the margin between the radial shields, but has a small supplementary plate at each end. The interradial area, beneath, is largely occupied by the large trap-

ezoidal or pentagonal plate adjoining the distal end of the mouth-shield, by two large, elongated genital plates, and by a submarginal row of about three or four angular plates, of which one or two, in the middle, are much smaller than the rest.

The mouth-shields are large, pentagonal, rather longer than broad, the length in the larger specimens being about 3.5 mm. and the breadth about 3 mm.; the distal margin is straight, or somewhat incurved; the lateral margins nearly parallel, and the inner edges are nearly straight, meeting nearly at a right angle. The side mouth-shields are narrow and oblong, with nearly parallel sides. The genital papillæ commence at the mouth-shields as a single row of small irregular granules, but become more numerous distally, and at the edge of the disk, near the base of the arms, form an elongated, triangular group of rather large, unequal granules, about twelve to fifteen in number.

The teeth are short, stout, angular, and blunt. The mouth-papillæ, in specimens 10 to 13 mm. in diameter, form a nearly regular close row of six to eight; they are small, short, blunt, flattened, and usually squarish in outline, though some are oblong, and twice as broad as high; toward the distal end of the mouth-slits more or less of the papillæ are often soldered together. In the largest specimens the mouth-papillæ become more irregular and often form two rows, besides a row of granules above them; those of the lower row are stout, blunt, conical, unequal in size; those of the upper series are much smaller, rounded or conical.

The inner tentacle-pores, in the large specimens, are bordered by six or seven short, blunt, squarish scales on each side; the second pair has three or four very small scales on each side; the third, about three minute scales on each side; and the fourth pair has two on the proximal, and one, more minute, on the distal side; beyond the fourth pair of pores, which are minute, no pores are visible, though a distinct pit exists, bordered by a single minute spiniform tentacle-scale on the proximal side, and by the lower arm-spine.

The arm-spines are usually three, very minute, and nearly equal; the uppermost is near the upper distal angle of the side arm-plate and widely separated from the others; the lowest is usually close to, or in contact with, the tentacle scale; the arm-spines are not more than one-fifth or one-sixth the length of the side arm-plates.

The dorsal arm-plates are thickened, but not much swollen, and are separated by rather wide and deep grooves; the two or three basal ones in the notch of the disk are short and small; the first free plate is shorter than broad, somewhat lunate; the plates succeeding this become constantly longer in proportion to their breadth; for a short distance from the base of the arms they are trapezoidal and have a strongly curved outer margin, straight convergent sides, and a narrow incurved proximal margin; beyond the middle of the arm they become triangular or wedge-shaped with the distal margin strongly convex

and the proximal ends forming an acute angle, while the side arm-plates meet more and more between them.

The side arm-plates are large, thick, and prominent, separated by deep furrows; on the ventral side they begin to meet at about the third arm-joint beyond the margin of the disk, and their length increases rapidly until it becomes twice that of the ventral plates near the ends of the arms; on the upper side they begin to meet at about the fourteenth or fifteenth free arm-joint.

In many of the larger specimens the dorsal plates are divided by an irregular median furrow into two parts, and in many specimens they are again irregularly divided into smaller portions by one or two more or less transverse furrows, so that they often appear as if composed of four or five irregular pieces; but in other specimens of similar size the plates are entire.

The first ventral arm-plate consists of two small wedge-shaped pieces between the innermost tentacle-pores; the next is much larger, about as long as broad, a little thickened, somewhat shield-shaped, or pentagonal, with rounded corners; the next is broad triangular, with the outer margin strongly curved and the middle of the lateral margins excavated for the second pair of tentacle-pores, and the inner end narrow and slightly truncated; those following become relatively wider, broad triangular, with a strongly curved outer margin, incurved sides, and more or less acute inner angle; beyond the middle of the arm they become relatively smaller, widely separated, and the inner margin forms a very obtuse angle.

Color, in alcohol, dull grayish or dirty brown.

Variations.—There is considerable variation, even among the adult specimens, while the young, 8 to 10 mm. in diameter, differ in many respects from the large ones. The number and form of the mouth-papillæ and tentacle-scales vary somewhat in specimens of the same size. The mouth-shields are sometimes more top-shaped or pear-shaped than in the specimens described; the lateral margins being convex with the corners rounded. The large plate at the distal end of the mouth-shield is sometimes divided into two or three parts, most frequently by the separation of the two inner corners as small triangular plates. The two lower arm-spines are not always close together, and sometimes four spines occur, the extra spine appearing either just below the upper one or just above the second.

In the young specimens, 8 to 10 mm. in diameter, the scaling of the disk is much more regular, and the relatively large primary plates form a pretty regular rosette. The mouth-shields are relatively shorter and more top-shaped. The mouth-papillæ and tentacle-scales are very regularly arranged and less numerous than in the specimens described. The first complete ventral arm-plate is prominent and rounded; all the ventral plates beyond this are separated by the side arm-plates. The next three or four lateral arm-plates are broadly turbinate, with the

outer border evenly curved, and the lateral margins form an obtuse angle. In some of the young specimens of this size there are four minute arm-spines on the proximal joints, three of them being placed together near the tentacle-scale.

Taken off the eastern coast of the United States at fourteen stations, between lat. 39° 35′ and 41° 47′, in 250 to 1,106 fathoms, most frequently between 400 and 1,000 fathoms. A single specimen was taken off Delaware Bay in 2,033 fathoms, at station 2,038, in 1883.

This species, when first discovered, was referred to *O. confragosa* Lyman, from off Patagonia, Mr. Lyman himself having made this identification after having examined one of our specimens; but the subsequent acquisition of a much larger series leads me to consider the two forms distinct, though closely related. Our form is easily distinguished by the single large plate external to the mouth-shields; by the more regular and more closely arranged disk-scales; by differences in the mouth-papillæ and tentacle-scales, and by the somewhat different form of the under arm-plates. In *O. confragosa* the radial shields are represented as being decidedly smaller and much more widely separated than in our species, while the large plate in the interbrachial margin is also much smaller. In the latter there are generally but three arm-spines, while in the former there are usually four.

OPHIOGLYPHA GRANDIS, new species.

A very large species with a swollen, pentagonal disk, covered with irregular, angular scales and rather small, short, irregular, widely separated radial shields. Arms high, with pentagonal dorsal plates and transversely elliptical ventral plates. Arm-spines three, small, subequal; the upper one considerably separated from the two lower ones. Mouth-shields broad, shield-shaped; about as broad as long. Tentacle scales numerous at the base of the arms.

Disk, in the type specimens, from 23 to 30 mm. in diameter; length of the longest arms, all of which are broken at the tips, more than 90 mm.

The disk is generally considerably swollen and plump, with the interbrachial margin nearly straight, or a little convex, and with only a slight notch at the bases of the arms, where there are usually no distinct arm-combs, but in those few specimens in which they occur they consist of a single row of from six to eight small, flattened, squarish, scale-like papillæ on each side, which decrease in size from below upward.

The central and other primary plates of the disk are distinguishable, but are only slightly larger than the intervening scales, which are numerous, irregular in size and form, often triangular, and more or less convex; the larger ones vary in diameter from 1 to 2 mm.; the primary plates are about 2 mm. in diameter. The radial shields are divergent

and rather widely separated by a group consisting of two large median and several smaller scales on each side; the radial shields are irregular, polygonal, or somewhat triangular in form, about as long as broad, with the outer end subtruncate or broadly rounded, and the inner end bluntly pointed and strongly divergent. The interbrachial areas beneath are covered with thick imbricated scales, similar to those of the back, and about 15 mm. in breadth.

The mouth shields are pretty regularly shield-shaped, the breadth about equal to the length, the outer margin broadly rounded or subtruncate, the lateral margins nearly straight, and the inner margins convergent to a point and forming sometimes a right angle, but usually an obtuse angle; side mouth-plates narrow, with nearly straight, somewhat divergent edges, with the widest end toward the jaw. Mouth-papillæ numerous and regular, acute conical, seven or eight in number, increasing in length as they approach the end of the jaw.

The genital slits are very long, extending from the mouth-shields to near the underside of the arms; they are bordered externally by a row of short, thin, wedge-shaped, or squarish papillæ, which stand close together in a regular row; those nearest the mouth shields are much the smallest and shortest, and are often nearly square, but in many cases are twice as broad as high; their height usually increases distally to the outer end of the slit, where they are sometimes flat, nearly square, and as long as the arm-spines. In many cases they are more or less soldered together into a continuous series, and in the larger specimen they are often partially wanting.

Innermost tentacle-pore very large, elongated, with about eight regular, flattened, obtuse papillæ on each side; on the next two pairs of tentacle-pores the papillæ are smaller, but nearly as numerous; on the fourth pair there are about four on each side; and on two or three succeeding pairs there are two; beyond that, only a single papilliform tentacle scale. At the base of the arms there are three small, papilliform arm-spines, nearly equal in size, the upper one separated from the two lower ones, which are close together; sometimes three spines appear in the lower group. They are about one-third the length of the side arm-plates; the upper one is often a little larger than the others.

The first under arm-plate is small and pentagonal; the second and third are considerably larger, pentagonal, about as long as broad; the third to the sixth separate the side arm-plates and are transversely elliptical, with an inner angle, broader than long; beyond this the plates gradually become shorter and relatively broader, and the side arm-plates come more and more broadly in contact. The upper arm-plates are strongly convex and prominent, but not much thickened; the three at the base of the arms are short and broad; the fourth is hexagonal, broader than long; beyond this the form becomes regularly hexagonal and the length becomes greater than the breadth, and dis-

tally the outer end becomes rounded and the form somewhat wedge-shape.

Station 2573, off George's Bank, in 1,742 fathoms (No. 12026, U. S. N. M.), 23 specimens, U. S. F. C., 1885.

OPHIOGLYPHA BULLATA, Thomson.

Ophioglypha bullata, WYV. THOMSON, Nature, VIII, p. 400, 1873; Voyage of the Challenger, Atlantic, I, p. 400, fig. 7.—LYMAN, Rep., I Ophiuroidea, Voyage of the Challenger, V, p. 57, pl. 38, figs. 14 to 17, 1882.—VERRILL, Rep. U. S. Com'r Fish and Fisheries, XI, p. 543, 1885.

The large series of specimens of this species taken by the Albatross shows that it is much more variable, especially in respect to the disk-scales, than Mr. Lyman's description indicates. The disk is generally very convex, but sometimes it is nearly flat. The disk-scales and radial scales are usually strongly convex and rough, with small granulations, but sometimes, in specimens from the same lot, they are almost or quite flat and nearly smooth, and in our large examples the large disk-scales and the radial shields are even concave in the middle. Usually the central and five radial primary plates form a regular and prominent rosette of large polygonal scales, without any small ones between them, but in some specimens several small, angular scales are interpolated between the large primary ones in various ways, and the latter are more or less obscured, so as to appear smaller and rounder. In the small specimens, with the disk 4 to 8 mm. in diameter, the six central plates are always conspicuous, thick and convex, and rise above the rest of the disk. There is usually a single, large, inferior, interradial plate, outside the mouth plates, but it is often divided in large specimens. The mouth plates are pretty constant in form. This species was taken at several stations in 1,608 to 2,620 fathoms.

ASTROSCHEMA CLAVIGERA, new species.

Disk small, with prominent radial shields extending to the center; the whole dorsal surface and that of the arms is covered with small smooth granules. Under surface of the arms and sometimes of the disk, nearly destitute of granules. First two tentacle pores without scales; third and sometimes the fourth with one spiniform; those beyond the fifth and sometimes the fourth with two spines, of which the inner becomes large and long, clavate, and rough with spinules distally.

The disk in the type specimen is concave in the middle, with strongly incurved interbrachial spaces, and large, prominent, rounded ribs. Diameter of disk, 8 mm.; breadth of arms at base, 3 mm. The arms are very long, and closely coiled around the branches of a gorgonian. Toward the base they are moderately stout, about as broad as high, then taper gradually to very slender tips; each of the joints is marked by an obtuse, elevated ridge, more or less divided dorsally into two prominences by a longitudinal depression along the median line. The

entire dorsal surface of the disk and arms is closely covered by small rounded granules, which vary but little in size, but those upon the radial shields are a little the largest. The under surface of the disk and arms of one specimen is covered with a smooth skin entirely destitute of granules, but another specimen of the same size from the same locality has the entire under surface of the disk, jaws, and basal part of the arms covered with minute granules, decidedly smaller and more spaced than those on the back; similar granules cover the lower part of the sides of the arms and the intervals between the plates beneath. The teeth are rather large, stout, somewhat spear-head shaped. In one specimen there is a row of three or four small, rounded, subacute mouth-papillæ; but in the other, the sides of the jaws are covered with many small granules like those of the disk.

The genital openings are large and wide, and together form a large pit in the middle of the interbrachial area, in the dry specimen; but in the alcoholic specimen they are large, oblong, rounded at both ends, converging somewhat below, and separated by a granulated depressed area, about twice as wide as their own breadth.

In both specimens the first two pairs of tentacle-pores are destitute of spines or scales; the third pair has but one, rather large spiniform scale; the fourth pair, indifferently one or two, on different arms of the same specimen; the fifth, sixth, and following pairs have two spines, which differ but little in size, but the inner is longer and rapidly increases in size, until it becomes more than twice as long and three or four times as thick as the outer one, on the middle portion of the arm, where a third small, short, spinule sometimes occurs above the two regular ones.

The large inner spine is round and usually somewhat swollen, or club-shaped, with a blunt end; the outer half is thickly covered with minute, sharp, rough spinules. The outer of the two spines is slender, and tapers gradually to a rather sharp point, which is more or less spinulous. Toward the tips of the arms the two spines become very small, slender, acute and nearly equal.

Variations.—The two specimens obtained differ considerably, as mentioned in the above description, in several characters. They are both from the same locality, attached to the same kind of gorgonian, and have the same size, color, and appearance. The most important difference is in the granulation of the under surface of the disk, which is entirely wanting in one specimen and well marked in the other; and in the presence of small mouth-papillæ in the former, which are entirely wanting, or represented only by granules, in the other.

Color in alcohol, salmon brown; the intervals between the arm-plates are darker brown than the plates, and the arm-spines are tipped with dark brown.

Station 2530, off George's Bank, in 956 fathoms (No. 11852, U. S. N.

M.), 2 specimens, clinging to a species of *Paramuricea*. Taken by the U. S. F. C. steamer *Albatross*, 1885.

This species is more nearly allied to *A. intectum*, Lyman, from off Havana, than to any other described species. It differs, however, in the character of the granulation, in the number and arrangement of the proximal tentacle-scales, and in having much larger and clavate spines on the middle portion of the arms.

NOTES ON THE ANATOMY AND AFFINITIES OF THE CŒREBIDÆ AND OTHER AMERICAN BIRDS.

By Frederic A. Lucas.
Curator of the Department of Comparative Anatomy.

Some five or six years ago I planned a paper on the Cœrebidæ which, for lack of time and material, has lain at a standstill until the present time. It is brought forward now, not because the necessary amount of material has been obtained, but because it seems probable that if delayed until the needed specimens are secured it will never be written, and also in the hope that these notes and figures may be of some service to other students and save the trouble of again going over the entire ground. It may, to some extent, be considered as a brief supplement to Dr. Gadow's paper on the Structure of certain Hawaiian birds, as comparisons are made with some of the species therein described.

One in search of the relatives of any passerine bird has before him, if not exactly a thankless task, something very nearly akin to it, and one in which even comparatively small results can be reached only by the expenditure of much time and labor. The birds which perch at the top of the avian tree are so many in number and so exasperatingly interrelated that any attempt at sorting them out is fraught with much difficulty, or, as Dr. Gadow puts it, "the examination of a small twig of the passerine branch of the Avine tree shakes and disturbs the whole branch, if not the whole top, of the famous ideal tree." So it has been in the present case. Representatives of the Mniotiltidæ, Meliphagidæ, Drepanididæ, Tanagridæ, and Fringillidæ, have been examined in the hope that the affinities of the Cœrebidæ might be made apparent; and I am compelled to confess that, on the whole, the result has been unsatisfactory, and that the examination of a considerable number of specimens has rather lessened my hopes that anatomical, and especially osteological, characters may be relied upon to show relationship among the passeres.

Of course one trouble lies in the fact that the so-called families of passeres, at least very many of them, are not families at all, or not the equivalents of the families of other groups of vertebrates. It is my belief that any group of vertebrates to be of family rank should be capable

of skeletal diagnosis, and this test applied to the passeres reduces them to a family or two, as has been done by Huxley and Fürbinger.

It would almost seem that, aside from purely negative results, the skeleton can be relied upon to show but two things, very general and very close affinities, for the variation of parts is so infinite that between any 10 given birds we may find every intermediate stage and establish relationships in all directions.

Then, too, characters which would be of much importance among mammals appear, from their instability, to be of but little value in birds. An example of this is found in the condition of the presacral vertebræ. In a large number of Passeres there are 4 presacrals, the third and fourth being fused and having a common transverse process; in others there are 5 presacrals, the fourth and fifth being fused. Such characters as these would seem to be of some importance, and yet *Himatione parva* has the third and fourth presacrals fused, while *H. sanguinea* has the fourth and fifth united. And these birds are undeniably closely related.

The same thing occurs again and again in other closely related species, such, for example, as *Merula migratoria* and *Turdus musicus*, while the instability of the character is well shown by the fact that it is by no means uncommon to find sacra in which, on one side, the third and fourth vertebræ are fused and on the other the fourth and fifth.

The degree of value to be assigned the pterylosis is yet unsettled, and this can only be done by accumulating and comparing the facts in the case. It would be a great service if some one with ample time and unlimited patience would plot the pterylosis, or even the configuration of the dorsal tract, in as many small birds as could be obtained, for it would then be possible to ascertain what correlation, if any, there is between tract pattern and other characters.

Between the continuous dorsal tract of a thrush and the inverted Y of a swallow there is a great difference, and this difference should have some definite meaning, exactly what meaning, is to my mind, not yet evident.

All the birds examined during the preparation of this paper have an uninterrupted dorsal tract whose shape appears to be specifically subject to great variation, but these variations are so slight and so innumerable that, except for general purposes, the pattern appears to be of little service.

The convolutions of the intestine are in very much the same case as the pterylosis for, judging by Dr. Gadow's figures and my own limited number of dissections, they are subject to great specific variation. There is certainly a decided difference between the alimentary canal (including the stomach) of birds so nearly alike as *Cœreba cyanea* and *C. cœrulea*, and the genera of tanagers vary widely.

The indications are, as might not unnaturally have been expected, that such parts as the tongue and alimentary canal are subject to great

variation, so that the skeleton would seem to offer the most stable characters for classification, although, as has so often been said, it is by the *resultant* of characters that we must be guided.

The members of the Cœrebidæ herein discussed are *Cœreba cyanea*, *C. cœrulea*, *Certhiola caboti*, *C. bahamensis*,* and *Glossoptila campestris*. The palatal regions of the skulls of these genera are figured, and reference to them will be better than any detailed description.

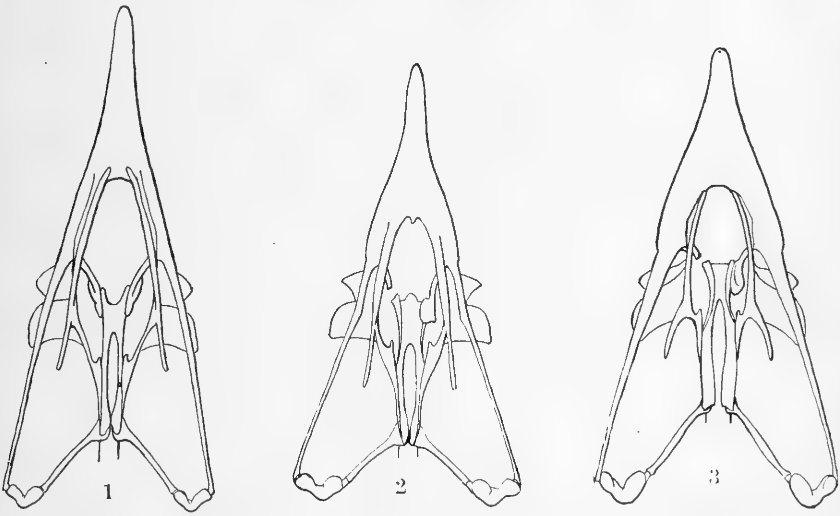

FIG. 1.—Views of palatal region of (1) *Cœreba cyanea*; (2) *Certhiola caboti*; (3) *Glossoptila campestris*; all enlarged.

The crania agree in the following particulars: the prepalatine bar is slender, the postpalatine portion produced backward and overhanging the anterior ends of the pterygoids. The anterior, interpalatine angle is small, almost abortive; the transpalatine process slender and spine-like. The more noticeable differences are as follows: In *Cœreba* the prepalatine is carried forward beneath the premaxillary; in *Certhiola* and *Glossoptila* it abuts upon and interlocks with the posterior, ventral part of the premaxillary. In *Cœreba* the palatine and pterygoid are completely fused; in *Certhiola* and *Glossoptila* they are separate. The pterygoids are anteriorly in contact, or very nearly so, in *Cœreba* and *Certhiola*; in *Glossoptila* they are separated by the sphenoid.

Certhiola and *Glossoptila* have septomaxillary splints united with the vomer. Dr. Parker figures them in *Chlorophanes atricilla*, and they are present in *Cœreba cœrula*, although I failed to find them in *C. cyanea*.

The tendinal perforations of the upper end of the tarsus, while arranged on the same general plan in those passerine birds examined, show a number of variations in the executions of details, some of which

* Also crania of *C. tricolor* and *C. portoricensis*. This last has the angle of jaw most produced of any species of *Certhiola* examined.

are shown in the figures. Their arrangement in the Cœrebidæ is very much that shown by *Myadestes*, except that in *Certhiola* 4 and 5 are merged in one.

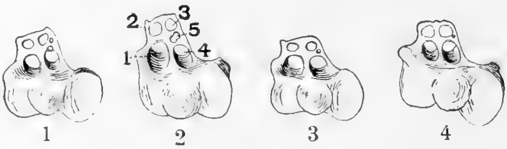

FIG. 2.—Hypotarsi of (1) *Phœornis obscura;* (2) *Merula migratoria;* (3) *Myadestes solitarius;* (4) *Hemignathus olivaceus;* all very much enlarged. The numbers in (2) refer as follows: [1] Foramen for tendon of *flexor longus hallucis;* [2] *flexor perforatus digiti* IV and slip to base of first phalanx of digit III; [3] *flexor perforatus digiti* III; [4] *flexor perforans digitorum profundus;* [5] *flexor perforans et perforatus digiti* II, and *flexor perforatus digiti* II.

The tongue is forked in *Cœreba* and *Certhiola*, brushy in *Certhiola*, laciniated or feathered in *Cœreba*. There is a decided difference between the tongues of *Cœreba cœrulea* and *C. cyanea*, as is shown by the figures.

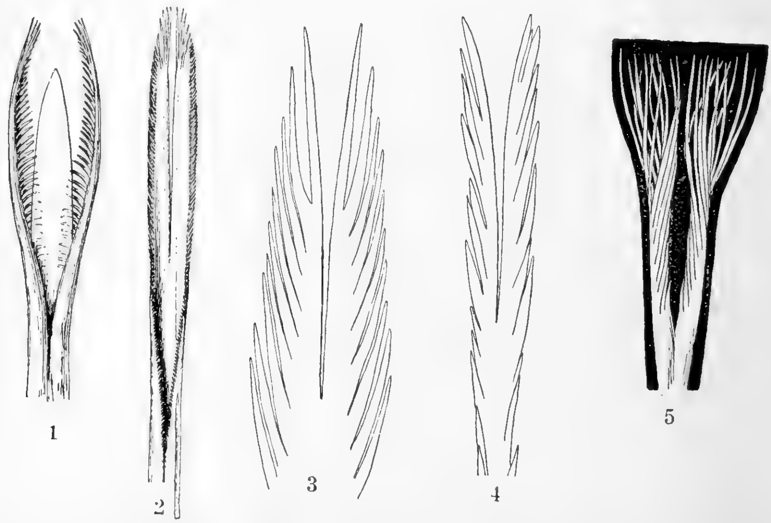

FIG. 3.—Greatly enlarged views of tip of tongue of (1) *Glossoptila campestris;* (2) *Acanthorhynchus tenuirostris;* (3) *Cœreba cyanea;* (4) *Cœreba cœrulea;* (5) *Certhiola bahamensis;* number one is viewed from below, the others from above.

Cœreba cœrulea comes near having a tubular tongue, but although the edges approach one another they do not meet except at the laciniated tip. In *Certhiola* the tongue is simply grooved down the center.*

Glossoptila is noteworthy, from the fact that it has a trifid tongue, a thin, flat, pointed strip being produced between the laciniated branches.

* It makes a decided difference whether the tongue is examined in a moist or dry condition, for in drying the outer edges curl upwards and render the tongue more tubular, or gutter-like, than in its natural state. The specimens from which the figures in this paper were made were all kept wet while they were being drawn.

Certhiola has no crop, *Cœreba* has a well-marked crop-like dilatation of the œsophagus, and *Glossoptila* has a good-sized crop. The stomach is small in *Certhiola*, a little larger in *Glossoptila*, and largest in *Cœreba cœrulea*. In all, the intestine is long and slender. There are many convolutions in *Certhiola*, comparatively few in *Cœreba*, while *Glossoptila* is somewhat intermediate between the two. In *C. cyanea* the intestine is ·090 mm. long, in *C. cœrulea* ·125 mm.; both have two small cœca a short distance above the anal opening. The food of *Certhiola*, as indicated by the stomach contents, consists of small insects and spiders, that of *Cœreba* and *Glossoptila* consists of small berries, containing numerous small seeds.

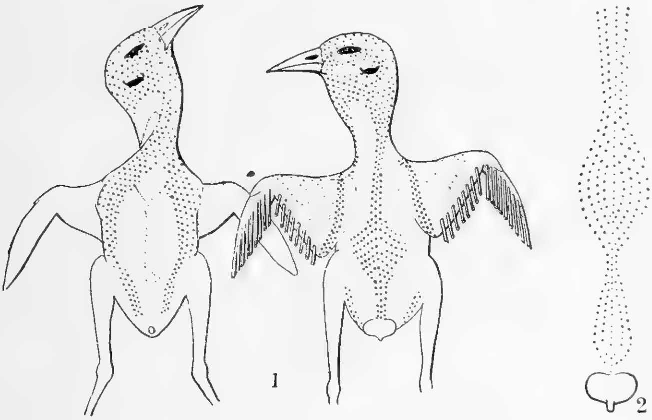

FIG. 4.—(1) Pterylosis of *Certhiola caboti*, a little more than half natural size; (2) Dorsal tract of *Glossoptila campestris*, natural size.

The feather tracts and apteria are, with trifling variations, as shown in the figure of *Certhiola caboti*. The pattern of the dorsal tract varies slightly according to the species, and the lengths of the median apteria, especially that on the under side of the neck, vary according to the length of the neck.

Glossoptila is different from the other Cœrebidæ in having a narrower dorsal tract, and much longer and looser feathers.

Professor Baird, in his "Review of North American Birds," considered the Cœrebidæ as nearly related to the Mniotiltidæ, being apparently largely influenced by the slender beaks of this last group, and by the peculiar tongue of *Dendroica tigrina*.

Dr. Gadow, in the "Birds of the Sandwich Islands," considers the Cœrebidæ as the nearest allies of the Sandwich Island Drepanididæ, this family being formed to accommodate the slender-billed brush-tongued birds peculiar to those islands.

Dr. Sclater* places the Cœrebidæ just before the tanagers, remarking that it is difficult to separate them from the tanagers on the one hand and the Mniotiltidæ on the other, and this position is that generally accepted.

* British Museum Catalogue of Birds.

In considering the relationships of the group, the pterylosis may be left out of the question, as it will not help us any. The figure showing the pterylosis of *Certhiola* might, with trifling alterations, do duty for *Cœreba*, *Dendroica*, *Geothlypis*, *Acanthorhynchus*, and some of the Fringillidæ, and since the same pattern is found in so many genera, including those but distantly related, it may be considered as very generalized.

The palate of the Mniotiltidæ differs from that of the Cœrebidæ in having the interpalatine process well developed, the transpalatine short and bluntly angular, and the palatines not produced backward over the pterygoids.

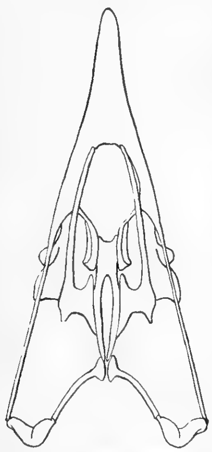

FIG. 5.—Palatal region of *Mniotilta varia*, enlarged.

In the general pattern of the palate, the shape and development of the interpalatine and transpalatine spurs, and in the amount of exposure of the sphenoid between the palatines, some of the tanagers agree very well with the Cœrebidæ. Others of the tanagers differ considerably in their palate from the Cœrebidæ, and there seems to be in the Tanagridæ more of an approach towards the union of the palatines beneath the sphenoid.

The Drepanididæ, as represented by *Vestiaria*, *Oreomyza*, *Hemignathus*, and *Himatione*, agree with the Cœrebidæ in the character of the transpalatine and interpalatine processes, and exceed them in the depth and production of the postpalatine. This feature is carried to its extreme in the Drepanididæ, and the same is true of the compression of the palatines, the free ventral edges of these bones approaching one another very closely, being in *Himatione sanguinea* almost in contact. The Drepanididæ have the sphenoid covered by the palatine, a feature which is not found in the Cœrebidæ, but occurs in some, although by no means all, or even in a large majority, of the Fringillidæ.* Among the skulls examined, those of *Certhiola* and *Himatione* bear the closest general resemblance to one another. *Cœreba* and *Glossoptila* have a small palato-maxillary, and so do some of the Mniotiltidæ. On the other hand, *Certhiola* and some species of *Dendroica* do not have this little bone.† It is wanting in *Dendroica discolor*, *coronata*, *pennsylvanica*, *Melospiza fasciata*, *melodia*, *Loxia curvirostra*, *Zonotrichia albicollis*, *Pipilo erythrophthalamus*, *Leucosticte griseonucha*, *Ammodromus* and *Parula americana*. Its exact value remains to be shown, for it appears in forms which are not related, at least closely, and drops out in some that

* That is, in the species which have come under my observation.

† The following species have a palato-maxillary: *Dendroica maculosa, vigorsi, æstiva, Cardinalis virginianus, Habia ludoviciana, Plectrophenax nivalis, Calcarius lapponicus.*

are nearly allied. It is present in the Swallows, but not in the Flycatchers or Thrushes; is well developed in such stout-billed Finches as *Cardinalis* and *Habia*, missing in *Coccothraustes*. It appears as a slender splint in *Plectrophanes* and *Calcarias*, and reaches a considerable size in *Rhamphocœlus* and *Pyranga*, while it is lacking in *Phœnicophilus*. None of the Drepanididæ and Meliphagidæ examined have a palatomaxillary.

None of the Mniotiltidæ or Tanagridæ have the angle of the jaw produced, nor do the genera *Cœreba* and *Glossoptila*. In *Certhiola*, however, the angle of the jaw is slightly produced, and this occurs in *Oreomyza*, *Vestiaria*, *Himatione*, and to a less extent in *Hemignathus*. The production of the angle is marked in *Acrulocercus*, and reaches a maximum in *Anthochœra carunculata*. *Acanthorhynchus* and *Tropidorhynchus*

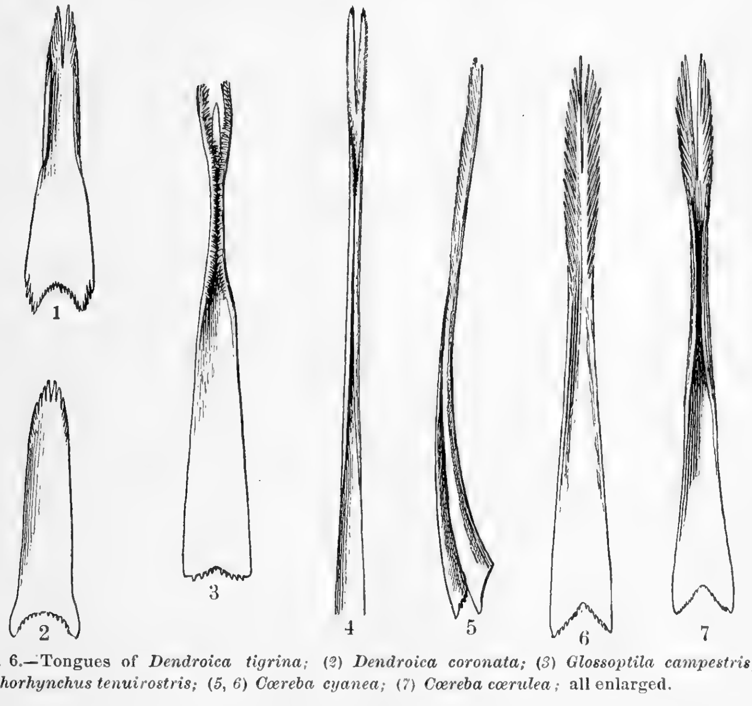

FIG. 6.—Tongues of *Dendroica tigrina;* (2) *Dendroica coronata;* (3) *Glossoptila campestris;* (4) *Acanthorhynchus tenuirostris;* (5, 6) *Cœreba cyanea;* (7) *Cœreba cœrulea;* all enlarged.

rhynchus do not have the angle of the jaw produced, although they are "tenuirostral" birds, and the character is one that seems to have no correlation with length of bill. Like many other points in the anatomy of the Passeres, more observations are needed regarding the occurrence of this character, although it would seem that it should be of some importance. It does not occur in many birds, but is found in some of the Icteridæ.

The tongue in the Mniotiltidæ is of moderate length, with very slightly upturned margins, cleft a little at the tip, and slightly brushy. *Dendroica maculosa* and *D. tigrina* represent the extremes so far as speci-

mens have been examined. The tongue shown in fig. 5, page 163, "Review of North American Birds," is unfortunately not the tongue of *Dendroica tigrina*. There has evidently been a transposition of specimens, and fig. 4, which is said to be that of *Dacnis*, is probably that of *D. tigrina*. As the shape of the tongue was the principal character of the genus *Perisoglossa*, the genus would for this reason, if for no other, be untenable; but even had the tongue been as figured, it would hardly seem a character of sufficient importance for the establishment of a genus.

The tongue of the Tanagridæ may be slightly bifid as in *Pyranga*, *Tanagra*, and *Rhamphocœlus*, or thick, fleshy, and fringed, as in *Saltator atriceps*, but so far I have found no species in which the tongue bore any resemblance to that of *Cœreba*.

Among the Drepanididæ, *Himatione*, *Hemignathus*, and *Vestiaria* have very perfect tubular tongues, the upturned edges meeting or even lapping over one another slightly, being so firmly apposed that it is often a difficult matter to force them apart. A few filaments at the end, and here and there along the edge, constitutes the entire feathering of the tongue.

Oreomyza has the commencement of a tubular tongue, but, owing to its shortness, the tubular structure is not carried out. None of these tongues are deeply cleft or widely feathered at the tip, as in the Cœrebidæ, and none approach the peculiar condition found in *Certhiola*, which has a two-branched tongue, with a twisted brush on either branch, and a shallow groove down the center of middle third of the tongue.

The general pattern of this tongue is very much like that of the Australian *Meliornis* while the nearest approach to such a tongue as that of *Cœreba cœrulea* is found in the Australian *Acanthorhynchus tenuirostris*, and in this bird the cœrebine pattern is carried to the extreme, the tongue being extremely long, slender, bifid, feathered at the tip, and tubular for a part of its length.

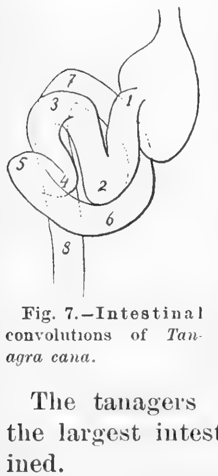

Fig. 7.—Intestinal convolutions of *Tanagra cana*.

The alimentary canal of the Mniotiltidæ is, as a rule, comparatively simple, but in *Dendroica coronata* the convolutions of the intestine are almost exactly the same as in *Cœreba*. The stomachs of all Mniotiltidæ examined contained insects. There is no crop in this group and the stomach is large and somewhat pyriform in shape.

The tanagers are fruit-eaters, are devoid of a crop, and have the largest intestine and simplest convolutions of any birds examined.

In the complexity of the alimentary canal there is a parallel

between *Certhiola* and the Drepanididæ, and the convolutions of *Hemignathus olivaceus* very nearly coincide with those of *C. caboti*.*

But in both groups there is varying complexity of convolution among the different species, and in neither is there any adherence to a given pattern. Among the Sandwich Islands birds there is, in the majority

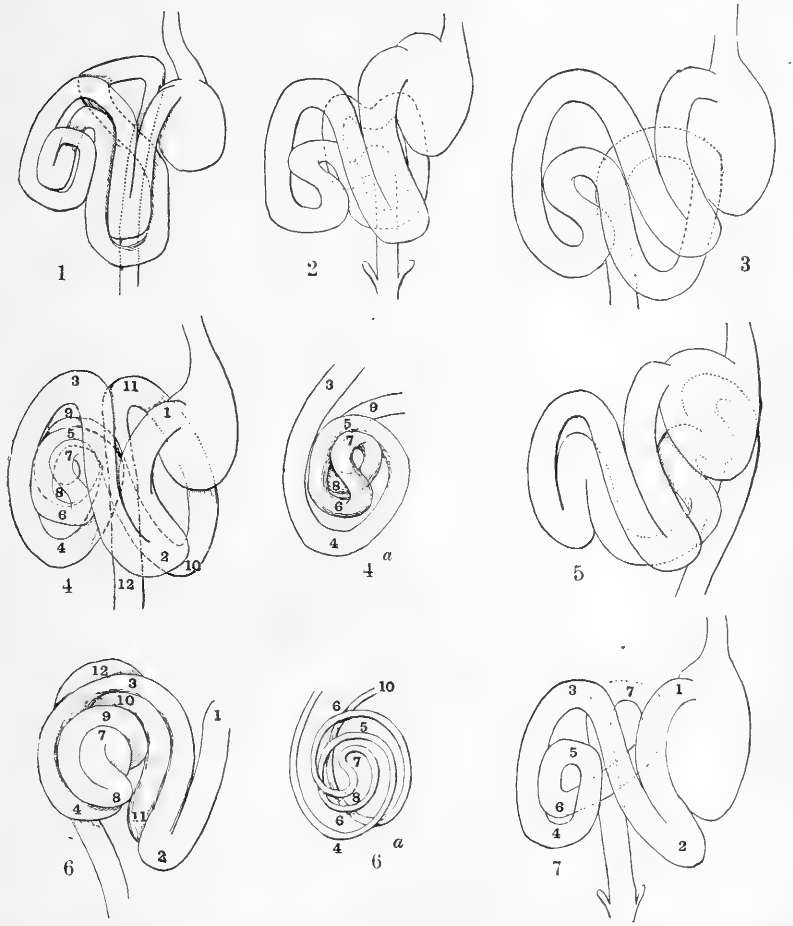

Fig. 8.—Intestinal convolutions of (1) *Glossoptila campestris;* (2) *Cœreba cyanea;* (3) *Dendroica coronata;* (4) *Certhiola caboti;* (4a) *Certhiola caboti*, central portion; (5) *Cœreba cœrula;* (6) *Hemignathus olivaceus;* (6a) *Hemignathus olivaceus*, with coil opened out to show convolutions; (7) *Acanthorhynchus tenuirostris*.

of specimens figured, a slight peculiarity in the manner in which the intestine begins to uncoil from the center. When looking from below at the right side of the viscera, the intestine is seen, roughly speaking, to start from the stomach and in a decreasing spiral or series of loops

* There is at first sight an apparent discrepancy between Dr. Gadow's figure and that shown in fig. 8 (6), of this paper, but this is due to the fact that Dr. Gadow's specimen has a longer and more closely twisted intestine, so that the point of reversion is different in the two.

coil into a knot or short loop, whence it uncoils or unfolds in an increasing spiral. In *Loxioides*, *Psittacirostra*, *Himatione*, *Vestiaria*, and *Hemignathus* the first turn of the intestine from the center is tc the left, while in the American species figured it is to the right. The point is one of little or no value, but among the species figured the difference exists.

My only specimen of *Acanthorhynchus* was doubly unfortunate; first in being neatly shot through the palate, completely destroying that region; and, secondly, in having the intestine in so tender a state that it was difficult to trace its convolutions. Hence I do not feel quite positive that the figure is entirely correct, although it is very nearly so, and if there is any error it lies in the portion beyond the central knot and consists in the omission of some convolutions. It is much simpler than in *Certhiola*, but not unlike *Cœreba*, while a little more complexity beyond the central knot would make the general pattern of the intestine very much like that of *Glossoptila*.

To sum up: In the character of their palate the Cœrebidæ differ from the Mniotiltidæ and resemble in some points the Drepanididæ and some of the Tanagridæ.

The Drepanididæ differ from all the above-mentioned groups except *Certhiola* in the production of the angle of the jaw.

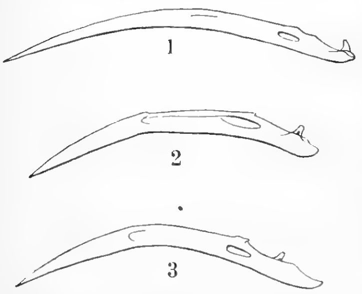

Fig. 9.—Lower mandible of (1) *Cœreba cœrulea;* (2) *Certhiola portoricensis;* (3) *Oreomyza bairdii;* all twice natural size.

In their tongue the Cœrebidæ are markedly different from the Mniotiltidæ, but it is largely a difference of degree rather than of kind. They differ *in toto* from the Tanagridæ, are quite distinct from the Drepanididæ, and find their nearest homologue in *Acanthorhynchus*.

As regards the Drepanididæ, it may be thought that this distinction is very much a matter of opinion, but to me the two patterns of tongue seem quite different, though both derivable from such a tongue as that of *Dendroica*.

It would, perhaps, require less modification to derive the tongue of the Drepanididæ from such an one as that of *Icterus icterus*, as this is considerably upcurved along the edges, is not greatly feathered, and is, considering its size, less fleshy at the basal portion than that of *Dendroica*.

It must be borne in mind, too, that there are three distinct types of tongue among the Cœrebidæ and that no comparison can be made with them in this particular as a group.

In complexity of alimentary canal they much exceed the Mniotiltidæ (except *Cœreba cyanea*, noted previously), bear no resemblance at all to the Tanagridæ, and are approached by the Drepanididæ.

As groups of birds are constituted the Cœrebidæ are certainly sufficiently distinct to stand apart, and the gap between them and the Mniotiltidæ seems widest, although this may be due to a tendency on my part to place considerable weight on the general pattern of the palate.

The relationship with the tanagers is not very close, although such short-billed forms as *Chlorophanes* and *Dacnis*, which unfortunately were not available, might bring the two groups a little closer.

In size, form, pterylosis, structure of tongue, and pattern of convolutions of alimentary canal, there is a strong resemblance between *Cœreba* and *Acanthorhynchus*, and so far the two forms exhibit a most interesting case of parallelism. The palate, too, on superficial examination, looks not unlike that of *Glossoptila*, but as Dr. Parker points out in the second part of his memoir on the Skull of Ægithognathous Birds, there is a striking dissimilarity in the fact that in *Acanthorhynchus* the palatines run outside the palatal process of the premaxillary instead of along the inner side, as in passerine birds generally.

Finally, it must be said that the members of the Cœrebidæ do not form a homogeneous group, for the family contains at least three well-marked types, *Cœreba*, *Certhiola*, and *Glossoptila*, and these types differ from one another in a very marked degree. While *Dacnis* and *Chlorophanes* have not been examined by me, the figures of skulls and tongues of these genera indicate that they belong near *Cœreba*. These genera form a well-marked group containing those species nearest to the Mniotiltidæ and characterized by a long, cleft, feathered, but not suctorial tongue, small crop-like dilatation of the œsophagus and simply convoluted intestine.

Certhiola has a bifid, brushy tongue, no crop, extremely complicated intestine, and produced angle to the mandible. The tongue resembles that of some of the Meliphagidæ; the other characters are like some found in the Drepanididæ. *Glossoptila*, with its loose ptilosis, decided crop and unique, trifid tongue, is equally well characterized and certainly should stand apart, seeming to hold with respect to Cœreba much the same position that *Chamea* does with the wrens.

The Anatomy and Affinities of Certhidia.

At the suggestion of Mr. Ridgway I have examined three specimens of *Certhidia salvini*, kindly provided by Dr. G. Baur, with a view of ascertaining whether or not the suggestion of Cœrebine affinities presented by its external appearance was borne out by its anatomy.

The pterylosis is of the orthodox passerine pattern and the dorsal tract has a diamond-shaped outline, similar to that found in *Dendroica* and many other small birds. The testimony of the skull is unmistakable, for it has the short, subangular, transpalatine processes, and well

developed interpalatines characteristic of the Mniotiltidæ, and well shown by the common warbler of this Galapagos group, *Dendroica aureola.*

The Cœrebine skull, on the other hand, is characterized by the fining down of the palatal region, the transpalatines being reduced to mere spikes, while the interpalatine spur is abortive or small. The cranium of *Certhidia* is a trifle shorter than that of the majority of the Mniotiltidæ examined and has a little more material in the palatines. The hypotarsus is also like that of *Dendroica* in its configuration, slight but perceptible differences existing between it and the corresponding region of any of the Cœrebidæ. There is apparently nothing specially characteristic in the shoulder muscles, their arrangement being practically similar in *Certhidia*, *Dendroica*, *Cœreba*, and many other small birds.

The tongue is warbler-like in shape and character, being moderate in length and slightly cleft and bifid. It is a trifle thicker and more fleshy than in such a bird as *Dendroica aureola* and not at all gutter-shaped. All this is in direct contrast to the elongate, feathered, hollowed-out tongue of *Cœreba*, and not at all like the cleft, brushy tongue of *Certhiola*, although all three forms agree in one respect: long or short, plain or feathered, the tongue is not suctorial, for even in long-billed *Cœreba* the hyoid stops low down on the base of the skull and lacks the elaborate arrangement of muscles found in truly suctorial birds. The intestinal convolutions are quite simple, much as in *Cœreba* and *Dendroica coronata* and *aureola*, but not exactly like either, although, curiously enough, precisely similar to the convolutions of *Cinnyris bifasciata*. There is, however, no crop-like dilatation of the œsophagus as in *Cœreba*. The cœca are moderate, and in the best specimen examined the *bursa fabricii* was very large.

All in all, the anatomy of *Certhidia* points to a very near relationship with *Dendroica*, and indicates that the genus surely belongs among the Mniotiltidæ.

Remarks on the Affinities of Myadestes and Phæornis.

The skull of *Myadestes* is rather short, and on its superior aspect bears a considerable resemblance to that of *Ampelis*. The maxillary process of the nasal is short, not expanded distally, and abuts upon, but does not fuse with the maxillary. In the thrushes this process is wider and continued for a little distance along the maxillary, but does not unite with it. *Phæornis* resembles the thrushes in these particulars. In *Tyrannus* the descending process of the nasal is narrowest near its origin, expands distally, and ankyloses with the maxillary.

The prepalatine bar of *Myadestes* is narrow, as in *Ampelis*, the transpalatine angle much like that of *Phæornis*. The interpalatine angle is blunter in *Myadestes* than in *Ampelis*, in this respect resembling that of *Phæornis* and the thrushes.

Tyrannus differs from the genera mentioned above in the early and complete fusion of the prepalatines with the premaxillaries. *Ampelis* is peculiar in the large symmetrical ossifications of the anterior trabeculæ which articulate with the vomer.

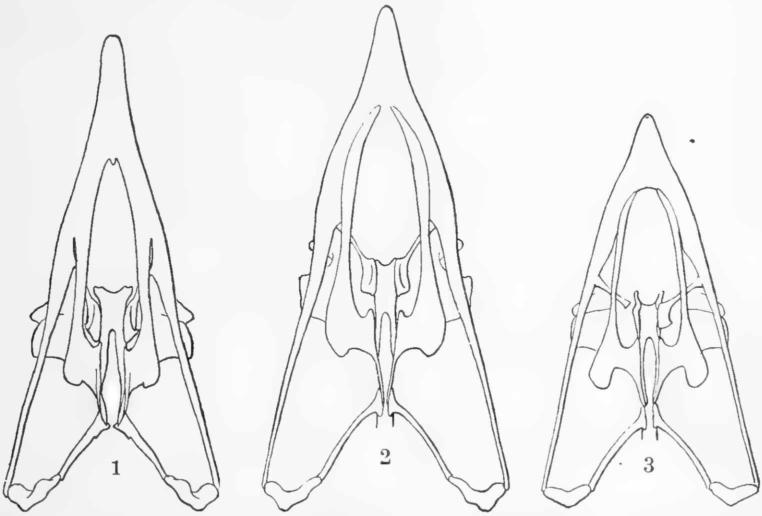

Fig. 10.—Palatal region of (1) *Merula migratoria*; (2) *Phaeornis obscura*; (3) *Myadestes solitarius*; all enlarged.

Myadestes, like *Tyrannus*, has a flat non-pneumatic maxillo palatine, although that of *Myadestes* is the less hooklike and more expanded of the two. *Phæornis* has a maxillo palatine like that of a thrush.

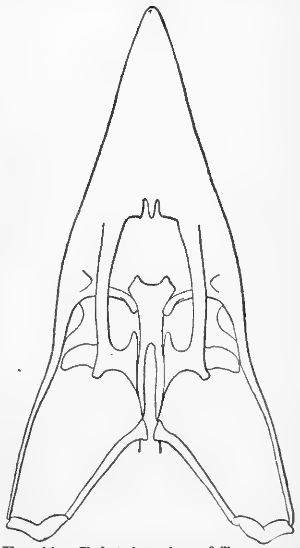

Fig. 11.—Palatal region of *Tyrannus carolinensis*, enlarged.

The manubrium of *Myadestes* is rather wide and low, similar to that of *Phæornis*, these birds in this particular departing from the thrushes as well as from *Ampelis*.

The œsophagus is large and there is no crop. The stomach is large, with strong walls. The intestine is very short, measuring but 0.145 m. in length. The stomach was full of small berries mingled with a few remains of insects.

The dorsal tract is almost straight in *Myadestes*, slightly different from what occurs in *Turdus pallasii*.

Myadestes was placed by Gray with the Ampelidæ, but is included among the thrushes by Dr. Stejneger.

While the bird has some leanings toward the Ampelidæ it seems to have more decided affinities with the thrushes,

although it is by no means a typical thrush. It certainly has no near relationship with the Tyrannidæ.

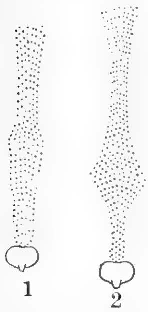

FIG. 12. — Dorsal tracts of (1) *Myadestes solitarius*; (2) *Turdus pallasii*; reduced.

Neither *Myadestes* nor *Phæornis* have any trace of a metapterygoid, but while this little process is quite generally present in thrushes, it varies greatly in the amount of development. It is best developed in *Merula aurantia* and *M. migratoria*, is small in *Turdus mustelinus* and *pallasi*, rudimentary or even wanting in *swainsoni* and *fuscescens*. When the metapterygoid is small it is occasionally difficult to decide whether a minute process is present, or merely a prolongation of the sphenoid foot.

The turdine resemblances of *Phæornis* have already been pointed out by Dr. Gadow, although he seems to have had doubts about positively placing the birds together. Working over the question anew my own observations corroborate those of Dr. Gadow, but I would go a step farther and until it was shown to be otherwise definitely place *Phæornis* with the Turdidæ. Certainly if *Myadestes* is to be considered a thrush *Phaæornis* is doubly one.

Remarks on the Affinities of Phainopepla Nitens.

Phainopepla was placed by Gray near *Ampelis*, and here is where it undoubtedly belongs. The skulls of the two are very much like, particularly in the palatal region, and both possess a large, free, swollen lachrymal, this last being a point of much importance, since such a lachrymal is of rare occurrence among birds. The quadrates of *Ampelis* and *Phainopepla* agree with each other in minute as well as general characters, as do also the pneumatic maxillo palatines.

The characters which separate *Myadestes* from *Ampelis* separate it also from *Phainopepla*.

The very marked resemblances between the skulls of *Phainopepla* and *Ampelis* render it, in this instance, unnecessary to go into further details, but it may also be said that the general contour of the dorsal tracts in the two species agree very well also, although the outer angles of the tract are a little more rounded in *Phainopepla* than in *Ampelis*.

FIG. 13.—Dorsal tract of *Phainopepla nitens*, reduced.

DISCOVERY OF THE GENUS OLDHAMIA IN AMERICA.

By Charles D. Walcott,
Honorary Curator of Paleontology.

In 1865 Prof. James Hall referred a fossil found associated with *Buthograptus* in the Trenton Limestone at Plattville, Wis., to the genus *Oldhamia*, under the specific name of *fruticosa*.* He described this form as "stems of corneus or carbonaceous texture, frequently branched, the branches again dividing and sometimes, if not always, in whorls, in one of which six divisions were counted." Prof. Hall's reference to *Oldhamia* was tentative and, from the study of Dr. J. R. Kinnehan's† beautiful illustrations of the genus *Oldhamia*, I am led to think it exceedingly doubtful if the species *fruticosa* should be referred to it.

Prof. Charles Lapworth mentions the occurrence of an *Oldhamia* in the purple slates of Farnham, Province of Quebec, like *O. radiata*, but does not describe or illustrate it.‡ It is placed in the horizon of the Upper Cambrian. Dr. R. W. Ells, of the Geological Survey of Canada, writes me that the Farnham slates belong to the Sillery formation. A poorly preserved specimen, received from the Survey, proves the presence of *Oldhamia*, but does not afford data for a specific determination.

During the field season of 1893, Mr. T. Nelson Dale, while surveying the areal geology of the Troy sheet of the U. S. Geological Survey, collected, in a belt of reddish shale that extends north and south, west of the Rensselaer plateau, a lot of annelid trails and plant-like impressions, which were sent to me with other material for determination. The only form that I can identify is a species of *Oldhamia* that is closely related to *Oldhamia antiqua* of the Cambrian rocks of Ireland.

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* Canadian Organic Remains, Decade II, 1865, p. 49.

† Trans. Royal Irish Acad., XXIII, 1859, p. 547.

‡ Trans. Roy. Soc. Can., IV, 1877, Table A, p. 183.

No other fossils were identified; and the determination of the geologic horizon is somewhat uncertain.

Genus OLDHAMIA, Forbes.*

The best illustrations of *Oldhamia* are given by Dr. J. R. Kinnahan† and Mr. J. W. Salter.‡ Prof. Brady§ discussed the genus and its relations to living forms, in 1865. He proposed to limit the genus to the *O. radiata*, and to refer the *O. antiqua* to a new genus—*Murchisonites.*

OLDHAMIA (MURCHISONITES) OCCIDENS, new species.

Frond with a jointed, slightly flexuous stem; fan-shaped fronds, formed of numerous simple filaments or attached to the upper end of each joint; the filaments being somewhat longer than the joints and giving the entire frond the appearance of a succession of tufts of filaments, each springing from the summit of the tuft below.

The specimens are preserved as casts on the surface of a smooth siliceous slate. No trace of cells or vesicles appear; and the position of *Oldhamia* in the classification of organic forms is not advanced. The

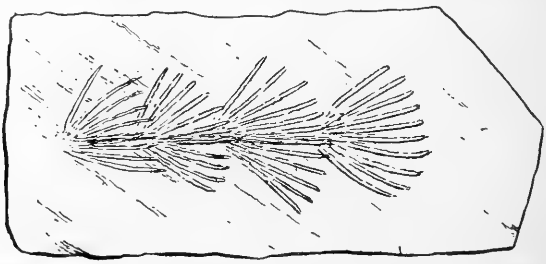

FIG. 1. *Oldhamia (M.) occidens.* View of a single frond from the gorge of the Poestenkill. Natural size.

suggestion that it is a calcareous alga appears to be as satisfactory as any. This species differs from *Oldhamia (M.) antiqua* Forbes‖ in the form of growth and arrangement of the tufts of filaments.

The specimens are from the Cambrian (?) slates.

The *Oldhamia* was first found in reddish shales associated with greenish shales and beds of quartzite, ranging from one to nearly twenty-two inches in thickness, at a saw-mill dam midway between Burden Lake and Nassau Pond in the township of Nassau; again in similar rocks about 2 miles farther up the same stream and 1½ miles SSE. from the south end of Burden Lake. It occurs also on the Moordener Kill,

* Journ. Geol. Soc. Dublin, 1848, VII, p. 184.

† Trans. Royal Irish Acad., XXIII, 1859, pp. 547–561.

‡ Mem. Geol. Soc. Great Britain; Geology of North Wales, 2d ed., 1881, pp. 471, 472, pl. 26.

§ Geol. Mag., II, 1865, p. 6.

‖ Trans. Geol. Soc. Dublin, 1848.

about $1\frac{1}{4}$ miles NE. of Schodack depot, in the township of Schodack, and in great abundance in the gorge of the Poestenkill, $1\frac{3}{4}$ miles east of Troy, near the Eagle Mills road, along the right bank of the river, which there flows south. The *Oldhamia* is here associated with various trails, and both cover large surfaces of the rock.

The slates are post-Lower Cambrian and pre-Trenton, but their exact stratigraphic position is not fully determined. They are either Upper Cambrian or Lower Ordovician.

NOTES ON REPTILES AND BATRACHIANS COLLECTED IN FLORIDA IN 1892 AND 1893.

By EINAR LŒNNBERG, PH. D.,
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THE following notes are based upon a collection made during a sojourn in Florida from September, 1892, to July, 1893, during which time I was engaged in general zoological collecting and research. The list contains the greater majority of the species recorded from that part of the United States, besides a number of additions to the herpetological fauna of Florida. The distribution of other species within the peninsula has been extended, or better defined. The biographical notes may not contain any strikingly new facts, but as such observations are not very commonly recorded, and as mine are based on personal experience they may possess some value as corroborative evidence.

I wish, finally, to express my grateful acknowledgment for kind assistance received from the authorities of the U. S. National Museum.

REPTILIA.

TESTUDINES.

PLATYPELTIS FEROX (Schneider).

The soft-shelled turtle abounds in all lakes and ponds in south Florida. It is caught with nets and seine and readily takes the hook. It is very savage and bites ferociously.

DERMOCHELYS CORIACEA (Linnæus).

This turtle seems to be known to some of the people living at Key West, but it is very rare. I have only seen one specimen in Florida, which had been caught near St. Augustine.

CHELONIA MYDAS (Linnæus).

Green turtles are still common along the coast of south Florida, but the time of extermination will soon come, as they are caught in great

numbers with nets, harpoons, pegs, etc., in the water, as well as on the beach when laying their eggs, the eggs being secured at the same time. The meat is sold at 10 cents a pound, and a good many are shipped North alive from the Key West market. The largest specimens reach a weight of 800 pounds.

ERETHMOCHELYS IMBRICATA (Linnæus).

The hawksbill turtle is caught at Key West, where I have seen some. It is not common, and very high in price on account of the shell. It is said to reach a weight of 150 to 200 pounds, but specimens of that size are very scarce.

THALASSOCHELYS CARETTA (Linnæus).

The loggerhead turtle is common all round the coast of south Florida, especially among the Keys. It is used for food in some places, for instance at Key West, although not so palatable as the green turtle, and the eggs are eaten whenever they can be found. The eggs are laid in May and June. During the latter month I found them on the Coronado beach at New Smyrna. Although the animals themselves are not always caught, the custom of taking their eggs is as destructive in the long run, and they are going to be exterminated on the coast of Florida sooner or later. They do not grow larger than 300 pounds.

DEIROCHELYS RETICULARIA (Latreille).

This species is not common so far as I know. I have only seen 2 specimens in south Florida, both of which were caught at Clarcona, Orange County, by C. C. Allen, who generously presented one of them to me.

PSEUDEMYS RUBRIVENTRIS (Leconte).

The red-bellied terrapin, or cooter, is not so common in south Florida as *Pseudemys concinna*, but I have seen it in several localities, viz, in the St. Johns River; at Clay Springs, Orange County; Silver Springs, Marion County, etc. It is to be found not only in the rivers, but I have caught it with the seine in small lakes in the neighborhood of Apopka, and have likewise received from Mr. C. C. Allen a specimen from Clarcona, Orange County. The plastron is sometimes uniform red; sometimes marbled with black.

PSEUDEMYS CONCINNA (Leconte).

This is the common cooter of Florida, in which country it is abundant in all lakes and rivers. They are very often seen in great numbers basking on old logs in the water, even in the middle of the winter. They feed on vegetable matter. The meat is white and very palatable.

MALACLEMYS CENTRATA (Latreille).

The valued diamond-back terrapin is caught in the salt marshes along the east coast. I obtained several specimens at Hillsboro River, outside New Smyrna, Volusia County.

TERRAPENE CAROLINA (Linnæus).

The box-turtle is not very common in the southern part of Florida. I saw only two specimens in Orange County, viz, at Apopka and Clarcona. It is said to be more abundant around St. Augustine.

GOPHERUS POLYPHEMUS (Daudin).

The "gopher" is common in the dry woods of south Florida. It is diurnal in its habits and is often seen walking about feeding between 11 a. m. and 3 p. m. When disturbed it retracts its head and feet with a hissing sound, like that of a snake, and sometimes tries to bite. The people do not use these animals for food, but sometimes chop them up and give them to the chickens. It is said that the holes are dug down to the ground water. A good many animals, as rabbits, snakes, frogs, etc., seek a refuge in the gopher holes, which are of particular protection to them when the grass in the woods is burnt off.

Lately there was discovered a quite interesting fauna of insects, partly blind, which live in these holes.*

KINOSTERNON BAURII (Garman).

At three different places in Orange County I collected this little turtle, which is new for the peninsula, but has been found at Key West and in Cuba before. I saw it first in Fern Creek, near Orlando, later at Apopka and Oviedo, in the same county. It is easily distinguished from *K. pensilvanicum* by the different development of the plastron and the color, etc. On the head there are always two pale yellow streaks, one from the tip of the nose backwards through the upper margin of the eye, the other one from the inferior margin of the eye and backwards. Below there are two broader bands of the same color on the inferior surface of the mandibula. The carapace shows three pale longitudinal bands. The shell is not smooth, but worn and eroded by parasitic algæ.

One of the specimens collected in Orange County is now in the U. S. National Museum (No. 21326).

KINOSTERNON PENSILVANICUM (Gmelin).

This species is quite common in some localities in the small lakes and creeks, etc.; for instance, in Fern Creek, near Orlando, Orange County. It is sometimes called the mud turtle.

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*Henry Hubbard, Science, XXII, August 4, 1893, pp. 57–58.

AROMOCHELYS ODORATA (Daudin).

The musk turtle is common in ponds and creeks in south Florida. In Fern Creek, for instance, it is abundant, and I have also found it in several other places in Orange County. One of my specimens from the above mentioned creek is very interesting on account of several anomalies of the plates of the plastron. The gular plate is divided by a very distinct suture and there is a pair of plates between the femoral and anal plates representing the anterior portion of the anals. The plastron is thus covered by 14 plates. Otherwise this specimen is typical in color and shape.

CHELYDRA SERPENTINA (Linnæus).

The alligator turtle is not very common in south Florida. I know of specimens from St. John's River, Lake Apopka, and the neighborhood of Oviedo, Orange County. As the head is very large, some ignorant people call it the "loggerhead," which name properly belongs to *Chelonia caretta.*

SAURI.

ANOLIS PRINCIPALIS (Linnæus).

The "chameleon" is common all over south Florida. It often enters the houses and frequently you can see this charming little animal climbing on the curtains in your room. It is interesting to see them run about in the sunshine and suddenly change color from brown to the most resplendent emerald green and to observe the males how after some nodding movement with the head they inflate the ruby colored gular sac. They are very fond of running on the thistles, where they readily find their way between the spines and prickles, being at the same time well protected by them against their enemies. The shape of the head varies considerably, but I am not able to draw any line between the short-snouted and the long-snouted ones, as there are all degrees of intermediates.

SCELOPORUS UNDULATUS (Daudin).

These lizards are very common in south Florida, in the pine woods and among the oaks in dry places, on old fences and houses, etc. When running on old burned stumps and logs in the pine woods, which used to be burned every winter to get better grass for the cattle, they are able to turn perfectly black. On light ground, for instance on oak bark, they resume their gray color with the brown undulations on the back, thus showing themselves possessed of a great faculty of adapting their color to that of the surroundings. They are sometimes called "alligator lizards," on account of the roughness of their scales.

OPHISAURUS VENTRALIS (Linnæus).

The "glass snake" has received its name because the tail is so very brittle. Ignorant people believe that the broken pieces are able to join

together again, and therefore call it "joint snake." This harmless lizard is also considered by them to be a very "poisonous snake." *Ophisaurus* is not scarce in south Florida, and I have found it in all kinds of places, in the dry pine woods, in hammocks, and under old logs at the border of lakes. It is a burrowing animal, and is therefore sometimes plowed up.

CNEMIDOPHORUS SEXLINEATUS (Linnæus).

This swift is extremely abundant on Key West, and the largest and nicest specimens in my collection were caught there. Although so abundant, it is hard to collect, as it is so very quick and active, running through the shrubs and disappearing "quick as a flash of lightning." In other parts of south Florida it is very common, too, in dry places in the pine lands, and on warm and sunny days may be seen all over the country in such places as, for instance, around Orlando and Oakland, Orange County, etc., but it does not seem to do as well anywhere as at Key West on the warm lime rocks and in the dense scrub.

EUMECES FASCIATUS (Linnæus).

This lizard is rather common in south Florida under rotten logs and stumps and similiar places. It is not confined to the hammocks, but is also found in the pine woods, in suitable localities, and I have seen a large specimen on the island south of Hog Island outside of Clear Water Harbor, Hillboro County. Strange to say, it is called "scorpion," "blue tail scorpion" or "big scorpion" and regarded as "awfully poisonous." The bright blue tail is very brittle and breaks always if one tries to catch the animal by that member.

LEIOLOPISMA LATERALE (Say).

This lizard is one of the smallest in south Florida, where it is abundant in hammocks under old leaves, etc., or on the shores of lakes under logs and stumps. The localities frequented by this skink are always more or less moist; the tail breaks off easily and is as easily reproduced.

RHINEURA FLORIDANA (Baird).

The "blind worm" or "blind snake," as it is called, is not scarce in sandy places in Orange county. It is often found by people digging or grubbing in the gardens or plowing in the orange groves.

SERPENTES.

CEMOPHORA COCCINEA (Blumenbach).

The amount of individual variation displayed by the present species seems to be considerably greater than one would suspect from a perusal of the literature. Baird and Girard * indicate a variation in the

* Catalogue of North American Reptiles, I, Serpents, p. 118.

nasal plate, a point brought out fuller by Garman,* who describes it as "entire, sometimes grooved or half divided, occasionally divided." The former authors also indicate a certain variability in the size of the supraocular. Finally, Jan has described a specimen as a separate subspecies which had the loreal extending to the orbit beneath the preocular.† My specimen, which is from a hammock near Lake Charm, Orange County, the only one obtained by me, has the nasal completely divided. In addition it has 7 upper labials, third and fourth entering the eye, the center of the eye above the fourth, and 9 lower labials, instead of normally 6 supralabials and 8 infralabials. It will be noticed, however, that Jan ‡ figures a specimen from New Orleans with 7 supralabials like mine, and Dr. Stejneger informs me that the U. S. National Museum possesses several specimens with the same number, for instance, No. 10741, from Clear Water, Fla., and No. 6298, from Fort Jesup, La. He also mentions 3 other interesting specimens, viz: No. 5221, from northern Alabama, which on one side has a rather large subpreocular wedged in between the second and third supra labials; No. 2387, from Anderson County, S. C., in which the rostral extends so far backward as to entirely separate the internasals; and No. 14828, from Georgiana, Fla., with the loreal and supraocular so small as to allow the prefrontals to separate them and enter the eye between them.

The size of the supraocular is not particularly small in my specimen; the number of temporals are 1+2+2; the number of gastrosteges about 180. The number of the latter is given by Garman § as varying between 157 and 174. In my specimen there are 17 pairs of black rings on the body and 6 on the tail, nearly the normal number. The specimen described by Jan and referred to above has an unusually large number of black rings, but Dr. Stejneger informs me that the U. S. National Museum specimen No. 6298 mentioned above has quite as many, but with the loreal normally related.

My specimen was obtained by digging in the ground. The burrowing habits of this species are evidently the cause of its comparative rarity.

FARANCIA ABACURA (Holbrook).

I obtained several small specimens in Lake Eola, at Lake Brantleg, and at other places in Orange County. Two larger ones were dug up in a "bay-head" at Oviedo, in the same county, in spite of the fact that the people there did not know it and had no name for it.

The U. S. National Museum has received a specimen from Arlington, Fla., No. 9583, collected in 1878 by Francis C. Goode.

ABASTOR ERYTHROGRAMMUS (Daudin).

I have not found this species in south Florida, but have seen a specimen caught not far from St. Augustine.

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* Garman, S., Mem. Mus. Comp. Zool. Cambr., II, p. 78 (1883).

† Iconographie des Ophidiens, livr. 11, pl. V, fig. 3.

‡ Loc. cit., fig. 1.

§ Loc. cit.

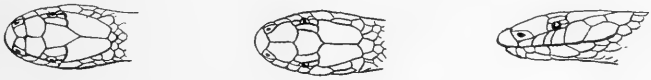
CONTIA PYGÆA (Cope).

I have but rarely found this little snake out of the water, and in such cases only under some log or board near the water's edge. It is common around the borders of the small lakes in Orange County, where I have seen and caught specimens in Lake Eola, Orlando, in and around some small lakes near Clarcona, Toronto, Apopka, and other places.

The number of supralabials is variable. In most cases there are 8, but I have two specimens with only 7, and one with only 6 on one side. In these cases of reduction the posterior ones have become fused, as shown by their size and the frequent presence of an incomplete section. The rows of scales are always 17 on all my specimens. The color of the upper surface is sometimes a little lighter on the sides, showing conspicuously on the three lowermost rows, at least, a narrow light stripe along the middle of each series. The belly is salmon-red without any spots, but in some specimens there is on the side of each gastrostege a short stripe extending to about a fourth or a fifth of the belly, forming the beginning of cross-bars.

STILOSOMA EXTENUATUM, Brown.

This rare and recently described snake* was hitherto known from one specimen only, the type. The three specimens obtained by me



1 2 3

Stilosoma extenuatum (twice natural size).

FIG. 1. Head from above (No. 21327, U. S. N. M.). FIG. 2. Head from above. Coll. Zool. Mus. Univers. Upsala, Sweden. FIG. 3. Head from the side; same specimen as fig. 2.

in Orange County, viz, one at Lake Charm, near Oviedo, the others at Oakland, deviate in their scutellation of the head to an extraordinary degree from the type, which appears greatly abnormal, so much so in fact that the generic determination became one of great uncertainty. One of the specimens has been presented to the U. S. National Museum (No. 21327), and submitted to the curator of reptiles, Dr. L. Stejneger, who is responsible for the identification as well as for the following remarks:

The type specimen of *Stilosoma extenuatum* is described as possessing no separate prefrontals (these being fused with the internasals), no loreal, and no preoculars. The large internasals join the supralabials and enter the eye, and the parietals join the supralabials behind the postoculars, excluding the temporals from the latter.

The three additional specimens seem to prove that the only normal and stable characters among the above are the absence of the loreal and the joining of the parietals and supralabials. The absence of the preocular is only found in the type, while the fusion of the internasals with the prefrontals is found in the type and in one of the Orange County specimens as well, but not in the other two, in which they are normally separated.

* BROWN, A. E., Proc. Phila. Acad., 1890, p. 199.

The absence of the preocular in the type of *Stilosoma extenuatum*, or rather its fusion with the prefrontals, at first led to suggestion of even more than specific difference, but a reflection upon the fact that the difference between the additional specimens themselves is fully as large as between them and type, coupled with the otherwise complete agreement with Brown's original description, soon led to the abandonment of such an idea.

The following additional remarks are derived from the specimen in the U. S. National Museum:

Hypapophyses absent in the posterior dorsal vertebræ; maxillary teeth eleven, all smooth, in a continuous series, the anterior and posterior ones slightly shorter than the others; pupil round; two pairs of well-developed, long chin-shields in contact on median line; preocular rather small, square, in contact with supraocular, prefrontal, second and third supralabials; six supralabials; temporals 1 + 2, the anterior one separated from postoculars by parietals which are very long; gastrosteges, 260; anal, 1; urosteges $\frac{40}{40}$ + 1. Total length, 330 mm.; tail, 23 mm.

Mr. Brown compares the coloration of the present species with that of *Rhinocheilus lecontii*, while Cope* states that it "has the coloration of the type of Hypsiglena or Sibon." None of these comparisons seem particularly happy, while on the other hand the similarity of *Stilosoma extenuatum*, so far as color and pattern, both above and below, is concerned, to *Lampropeltis calligaster* is very striking indeed. Even the head markings are almost identical.

On the whole the totality of the characters seems to place this genus among the coronelline snakes rather than with the calamarines, in spite of the marked tendency to a reduction of the number of head-shields by fusion, and it may be well in this connection to call attention to the unusually great number of gastrosteges, viz, 235–260.

LAMPROPELTIS GETULUS (Linnæus).

Rather common in south Florida, where it is sometimes known under the name of "king snake," and is then said to kill and devour the rattlesnake. Sometimes it is called "rattlesnake pilot," and is then regarded as the guide of that snake!

My specimens have the normal number of 21 rows of scales, while Cope has examined some Florida specimens with 23 rows. The coloration varies greatly. Sometimes the yellow centers of the scales result in more or less well-defined crossbands on the back and the yellow color on the interspaces is less conspicuous. Sometimes there are no distinct crossbands and then the snake looks brown or yellow, depending upon the development of the yellow centers of scales, which sometimes occupy nearly their entire surface. The crossbands, when present, often bifurcate on the sides, embracing darker areas. In this variety the crossbands and forks are narrow, becoming broader inferiorly, often as broad as the dark areas.

Most specimens of mine from Florida have yellow centers on the scales, more or less, even if they are crossbanded. A more typical *L. getulus* black with whitish crossbands, was caught at Savannah, Ga., by Capt. C. Eckman, and presented to the Upsala Museum. *Lampropeltis getulus* is of a rather gentle disposition. When caught they never

* Proc. U. S. Nat. Mus., XIV, 1891, p. 595 (1892).

tried to bite, only one opened its mouth, but they wind themselves round one's arm, showing great muscular strength. When they get alarmed they often rattle with the tip of the tail, trying to scare the enemy.

I have seen eggs laid by an *L. getulus* in captivity. They were rather large, whitish and with soft skin.

All my specimens were taken on dry land.

OSCEOLA ELAPSOIDEA (Holbrook).

I have one specimen of this beautiful snake from Key West, and another from the neighborhood of Toronto, Orange County. In both there is on one side a small rudimentary loreal, but on the other side the prefrontal extends to the upper labials. One who has seen both *Cemophora* and *Osceola* can not well confound them afterwards. The shape of the head is entirely different. *Osceola* deserves well the cognomen "*elapsoidea.*" The form of the head is very similar to that of an *Elaps*, and so are the colors, black, red, and yellow, although arranged differently. On the specimen from Toronto the seventeenth* pair of black rings is situated over the anus and there are five pairs on the tail, the last not complete. On the specimen from Key West the sixteenth* pair is situated over the anus. On the latter specimen the black rings are broader and cover 4–5 scales, and in the middle of the back they have a tendency to extend into the red spaces, so that, for instance, the posterior one of the twelfth, thirteenth, and fourteenth pairs extend through the red, meeting the anterior band of the thirteenth, fourteenth, and fifteenth pair respectively. It is remarkable that the yellow rings, although narrower, are never intruded upon. The fact that in *Elaps fulvius* the red, but never the yellow, is very often dotted with black, forms an interesting parallel.

DIADOPHIS PUNCTATUS (Linnæus).

Having obtained this snake only once, not far from Apopka, Orange County, in April, 1893, I must regard it as rather uncommon in that part of the State.

My specimen has two anterior and three posterior oculars instead of 2–2, but is otherwise typical as to scutellation and color.

There are nine specimens of this species in the U. S. National Museum from Florida, included under the following catalogue numbers: No. 10585 from Clear Water, collected by S. T. Walker; and Nos. 11984, 13667, 13702, from Georgiana, by Wm. Wittfield.

OPHEODRYS ÆSTIVUS (Linnæus).

This beautiful and gentle little snake is to be found all over south Florida down to Key West in "hammocks" and "scrubs." It is often

* Including that on the neck.

seen in orange trees. I have never observed it on the ground. It never tries to defend itself in any way.

BASCANION CONSTRICTOR (Linnæus).

The black snake is the commonest snake in South Florida and may be seen everywhere—in the dry pine woods, in the small prairies, at the borders of the lakes, on the ground, or climbing trees, or escaping down into the "gopher" holes.

At Acadia, De Soto County, I captured a small black snake which was crawling on the upper leaves of a palmetto, and as it presents some peculiarities it may be well to describe it in detail. It was very slender, being 600 mm. in total length, with a tail measuring 180 mm.; body compressed and head much broader than neck. The color of the upper surface is as black as in any full grown *B. constrictor;* the belly is likewise black, but with a narrow median stripe of small, whitish, cloudy spots; chin, throat, and upper labials whitish; this color extends back over the first 17 gastrosteges, the posterior ones of which are spotted with black. When killed the belly was speckled all over with round orange-red or rusty spots of a diameter of 1 to 2 mm., but these have disappeared in alcohol. Tip of tail underneath, yellowish. Scale rows, 17. Eight supralabials instead of 7 as usual in *B. constrictor.* Three postoculars, a peculiarity shared in by another full-grown specimen in my collection. On the whole there seems to be a great variation in the number and relation of these scales and in the temporals, of which there are 6 on one side and 7 on the other in my specimen.

According to Dr. Stejneger, to whom I have submitted the specimen for examination, it is a young one in transition to the adult coloration, which it has not yet quite fully acquired.

BASCANION FLAGELLUM (Shaw).

This species is not so abundant as the foregoing one, and is mostly found in dry pine woods in which the soil is rich enough to allow oak trees to grow. It is common around Oakland, Orange County.

It is known as the "coach whip" and sometimes the larger ones are called "chicken snakes," like several other of the larger colubrine snakes. Although a bold fighter and sometimes even found to be the attacking party, it is, of course, perfectly harmless, though some of the ignorant natives fear it greatly, believing that with "a blow of its tail it can break the arm of the largest man."

CALLOPELTIS GUTTATUS (Linnæus.)

I have specimens of this snake from Ozona Hillsboro County, Orlando, Oakland, Apopka, Oviedo and other places in Orange County; from the dense scrub at Coronado beach, New Smyrna, in Volusia County, and from Key West. It is known by different names in different places; for instance, "chicken snake" at New Smyrna and Key

West; "house king-snake" at Oakland, etc. It rattles its tail when offended, and one of my specimens tried to defend itself by biting. Like the following species, it often enters into the houses to hunt rats. The color is different in different specimens. I have not obtained any typical *C. g. sellatus* (Cope), though on the specimen from Key West the head bands are more obscure and the lateral spots not well defined, some of them—the posterior ones—being rather faint and disappearing on the tail; many of the dorsal spots are open on the sides, having only anterior and posterior dark borders; only the anterior part of the lower surface is regularly tessellated with black spots; further back there is only a trace left of each black square, and the abdomen thus becomes finely mottled with blackish scales not keeled.

Another specimen from Orlando shows variations in the direction of *Callopeltis rosaceus* (Cope). The belly is checkered and the head is banded in the normal way, but on the back two dark brown stripes extend all the way through the dorsal spots. On the anterior part of the body the lateral black borders of the dorsal spots, as well as the upper black borders of the lateral spots, extend longitudinally from one spot to another, in this way forming longitudinal stripes. A little further back this double black stripe is interrupted, but a less sharply defined brown stripe connects the lateral black border of an anterior dorsal spot with the next behind. Still further back even that brown stripe disappears, and the spots have the same appearance as in a common *C. guttatus*. Even in a young specimen from Ozona, Hillsboro County, there is a tendency to a longitudinal connection of the spots on the sides of the anterior part of the body, but there are no longitudinal dorsal stripes to be seen. The above-mentioned variations are very interesting, and in the future, I suppose, there will be found more connecting links between the various forms clustering around *C. guttatus*.*

CALLOPELTIS QUADRIVITTATUS (Holbrook).

I have obtained specimens of this form from different places in Orange County. It is often found in trees, being a very good climber. It enters very often the houses to hunt rats. Caged birds frequently become its prey on such excursions. Why the larger specimens are called "chicken snakes" is easy to understand.

The young ones are spotted, and sometimes these spots remain conspicuous in older specimens, too. I once saw quite a large specimen shot in a packing house, where it had been a regular guest for some time. This snake measured nearly two meters and had large yellow saddle blotches on its back. It was too much damaged to be preserved.

SPILOTES CORAIS COUPERII (Holbrook).

This snake, which is generally called "gopher snake" in south Florida, is not very common. I have obtained only one specimen from

* From Savannah, Ga., I have a specimen of *Callopeltis spiloides* but I have not seen this species in Florida.

the neighborhood of Orlando, Orange County. It had 7 superior labials on the right side and 8 on the left, showing plainly that this character is not constant.

The red on the throat is more or less developed in different specimens. The gopher snake is one of the largest snakes in Florida, and one often hears of specimens of extraordinary size. I have seen some stuffed specimens in St. Augustine which were about 10 feet in length.

I do not know much about its habits, but it seems to prefer high and dry land. It is said to be rather slow moving.

PITUOPHIS MELANOLEUCUS (Daudin).

The common form of this snake in South Florida has large, reddish saddle blotches on the back, becoming anteriorly more and more obsolete and finally showing only a slight mottling on the yellowish gray ground color. I have a smaller specimen on which the dorsal spots are blackish or dark brown, corresponding with Holbrook's figure.* The number of spots on the body is about 28, but the anterior ones are dissolved into smaller ones and difficult to distinguish. Two faint bands can be seen from the eye to the seventh supra-labial and from eye to eye in a curved line across the posterior part of the prefrontals. Supralabials, 8; ocular, 1–4 on the left side, 1–3 on the right.

From its loud hissing it is called "bull snake," and "pine snake" from its living in the pine woods. All the specimens observed by me are from dry, sandy pine woods in Orange County.

The skin of a very large specimen measured, without head and tail, 170 c. m. and must have been at least 2 m. This skin was given to me as the skin of a "chicken snake."

A very large specimen when caught hissed loudly and opened its mouth, but did not bite. It rattled its tail at the same time.

HETERODON PLATYRHINOS, Latreille.

The spreading adder is very common in South Florida. I have seen it most frequently in dry places in the pine woods, "highland hammocks," orange groves, etc. In the last named it is often plowed up.

Although the spreading adder is not a poisonous snake, it is very much dreaded as such. If it should bite it would probably inflict a considerable wound with the large posterior teeth. I have heard of two or three cases in which spreading adders are said to have bitten. These may, nevertheless, be regarded as rare exceptions. In one of these cases it was said that the hand of the bitten man swelled up considerably. He believed that the snake was poisonous, and so did the doctor, therefore the patient was ordered to drink so much whisky that he was nearly killed, and the doctor applied digitalis and other strong poisons. The man was a strong fellow and survived the treatment.

* HOLBROOK, J. E., North American Herpetology, 2 ed., IV, pl. i.

The bites of harmless snakes may become dangerous from several reasons: (1) Common blood poisoning that can happen with any wound; (2) poisoning with the poison from the skin of toads, in cases of bite by species feeding on these animals, as I often have observed that it is possible for some of the secretions from the poison glands in the skin of the toad to remain in the mouth of the snake among the teeth, especially the larger posterior maxillary teeth which inflict the wound; (3) fear that the snake is poisonous and consequent self-suggestion.

A large specimen of the black spreading adder *Heterodon platyrhinos niger* (Daudin) that I received in Orlando, Orange County, from Mr. L. Robinson, did not act quite like the gray specimens of the same species. It flattened the head and the neck, but not the body, and made itself very thick. The gray ones used to keep the head down to the ground during their contortions, but this one raised the head, moved it forward and backward, hissing very loudly but without biting. The hissing sound was produced at the time of expiration; at the time of inspiration there was a weak snoring sound.

THAMNOPHIS SIRTALIS (Linnæus).

This beautiful snake called "Grass snake," or sometimes "Garter snake," is quite common in wet places in south Florida, where I have obtained several specimens from different places in Hillsboro, Orange, and Osceola counties. They vary in color, some being more brown, others more green or bluish green; in some the spots are more distinct, in others the stripes, but in all my grown specimens stripes as well as spots are conspicuous, and all belong to the typical form. A young specimen caught at Lake Eola, Orange County, has no stripes, but two rows of square spots on each side, and is thus similar to *Thamnophis sirtalis ordinata* (Linnæus).*

The grass snake is ill-tempered and even a small one will bite ferociously.

A big female of this species, kept in captivity by a taxidermist, one night gave birth to about 40 young ones that were scattered all over the floor when the owner entered the store in the morning.

THAMNOPHIS SACKENII, Kennicott.

This species is said to be characteristic for Florida. I obtained 3 specimens at Oviedo, Orlando, and Apopka, in Orange County. All were caught in the grass in wet places. A specimen in the Upsala Museum, collected by Capt. C. Eckman, at Savannah, Ga., has 8 labials on one side, but 7 on the other, and another specimen from the same place has only 7 on each side. They are olive green but approach *Th. saurita* so much that I hardly think *Th. sackenii* can be maintained except as a southern variety.

* *Tropidonotus ordinatus*, HOLBROOK, North American Herpetology, 2 ed., IV, pl. xii.

LIODYTES ALLENII (Garman).

In a cypress swamp a few miles south of Kissimmee, Osceola County, I killed a big moccasin (*Agkistrodon piscivorus*), and found in its œsophagus a smaller snake which it had probably just swallowed. It was well preserved, except in one place on the middle of the body, where it had probably been bitten by its devourer. This is the only specimen of *Liodytes allenii* that I have happened to find, and I suppose it is scarce. It corresponds with the description given by Cope, viz:* Color dark brown with two brownish-yellow stripes on each side; below straw color; to which I can add a median row of blackish-brown spots, one on each gastrostege and a median zigzag stripe of the same color underneath the tail between the scutella. The single internasal and the five rows of keeled scales on the tail are very characteristic. The fact that the scales on the tail are keeled, as well as the circumstances under which I found it, indicate that it is a water animal.

Oculars 2–3 in my specimen, but in another in the Upsala Museum,† caught by forest inspector Westerlund, probably at Oakland, Orange County, the oculars are 1–3 (now No. 21388 U. S. N. M.).

NATRIX COMPRESSICAUDA (Kennicott).

Wading through a mangrove swamp at Key West I met, one day, with a blackish looking snake that came rapidly swimming through the water. I caught it and have classified it as belonging to this species, but the color is different from the "subspecies" Cope gives.‡

I will describe it, and if a name should be needed "*obscura*" is a good and suitable one. Scales in twenty-one rows. The color of the back is dark blackish gray, "soot color." On this ground the three series of spots can scarcely be distinguished, except on the anterior part of the body, where they form transverse bands; the head is too dark to show any postocular bands; upper and lower labials as well as mentals, with yellowish spots; the ground color of the belly is gray, a little reddish. On each side on the dorsal margin of the gastrosteges there is a small light spot, a median black band extends from the first gastrosteges to the tip of the tail. On the anterior part there is a yellowish spot on each gastrostege in this black band and the thirty anterior spots cover this band nearly completely, but further back they become smaller and less distinct, disappearing on the tail.

Two of Cope's subspecies have twenty-one rows of scales, viz, *N. c. compsolæma* and *N. c. compressicauda*. The former is very different from this form, having "numerous dark crossbands, narrowed on the side; three gular yellow bands; a postocular band." The latter has "three rows of dorsal brown spots forming longitudinal bands on neck; one

* Proc. U. S. Nat. Mus., XIV, 1891, p. 666 (1892).

† Since presented to the U. S. National Museum and catalogued as No. 21388.

‡ Proc. U. S. Nat. Mus., XIV, 1891, p. 669 (1892).

row of gular spots; no postocular bands." This one resembles somewhat the specimen from Key West, which is an intermediate form, but is darker than either.

NATRIX FASCIATA (Linnæus).

This snake is very variable in several respects. The typical specimens of *Natrix fasciata* have the back with dark, nearly black, crossbands, or broad transverse spots on a lighter ground, usually brown or reddish brown; the black transverse spots are mostly bordered (at least on the sides) with narrow, yellowish stripes; the belly in different ways spotted or crossbanded with black. This is the commonest form in south Florida. Next to this type comes another, in which the ground color is more grayish brown or dull-brown, with narrow transverse (yellowish) lighter bands, which are surrounded or margined with broader blackish borders. Sometimes these bands are less distinct. Of this form I obtained several specimens from Orange and Osceola counties. A single specimen from Lake John, Orange County, had the back uniform brown (about chestnut color), but when the old skin was removed it was seen that only the back was marbled with black, which did not extend toward the sides, there being on the flanks a single row of large red spots. Belly spotted with red, denser on the posterior part and the underside of the tail. Only a small black spot on each side indicates the postocular band.

Another variety, still more distinct, is the one I found in February, 1893, at St. John's River, not far from Lake Jessup; if more specimens of the same kind should be found it may be regarded as a subspecies, for which I would propose the name *Natrix fasciata atra*. It may be described as follows: Head rather large and broad; body stout, with very strongly keeled scales in 23 longitudinal rows. Preocular, one; postoculars, two. Supra-labials, on one side, eight; on the other, nine. Above, uniform black; only a few scales on the posterior portion, with yellow centers; underneath, yellowish white, with the anterior part of each gastrostege black, thus forming narrow crossbands. The habitus is so different from *Natrix fasciata* that it struck me at once, and when first seen it reminded me strongly of a moccasin. It did not attempt to escape, but coiled up ready to strike. I was not quite sure about its non-poisonous nature until I had caught it and opened the mouth. It was 78 cm. long, of which the tail measured 22 cm.

The various forms of *Natrix fasciata* are often called "water moccasins" and regarded as poisonous and dangerous snakes. Although they are harmless they are "unpleasant and ill-tempered," as Jordan says.* In some lowland swamps in south Florida they are extremely abundant. At Arcadia, De Soto County, for instance, I once saw half a dozen in less than a minute. They used to stay at the borders of

* JORDAN, D. S., Manual of the Vertebrate Animals of the Northern United States. 5 ed., Chicago, 1888. p. 194.

ditches and ponds or lie, resting, on floating boards, stumps, etc. At the approach of a person they dive and hide in the mud, but if they can not escape they bite wildly.

NATRIX CYCLOPION (Duméril & Bibron).*

I obtained only one specimen of this rare snake, and that one is small, though it is easily recognized. Scales in 29 rows; two small subocular plates, or scales, on each side. Temporals, 1-2, and a third one behind these, not touching the anterior one. The temporals indicate the difference from *N. taxispilota*, and the number of scale rows the difference from the *N. fasciata* group. The color is light grayish brown, with numerous narrow, dark crossbands, which are partly broken up into six series of spots. My specimen is from Orange County.

NATRIX TAXISPILOTA (Holbrook).

Of this big water snake I saw quite a number on the shores of Lake Apopka, Orange County. They may be seen resting on objects floating in the water, or on grass and branches overhanging the water, always diving when approached. I could not catch any alive, but had to shoot them in order to obtain specimens.

One large female had on the right side the normal number of oculars, viz, 1–2, but on the left side 1–3. Another had on both sides 2–3 oculars, and the same is the case with a smaller male specimen. When the oculars are 1–2 the eye rests on one of the labials, but when there are 3 postoculars the lowest one separates the eye from the labials. The number of oculars is consequently quite variable and seems to be of but little use as a specific character. The reduced size of the parietals, however, as well as the number of temporals, shows that my specimens belong to *N. taxispilota*. The male specimen has 29 rows of scales. The ground-color is mostly grayish brown, with alternating darker dorsal and lateral square spots which do not touch each other. Other specimens are darker, nearly black, and then the spots become less conspicuous.

STORERIA DEKAYI (Holbrook).

At Kissimmee, Osceola County, near the shore of the Lake Tohopekaliga, I found a specimen of this snake. It was in February, and, although the day was warm and sunny, the snake was hidden under a piece of board. The upper part of the forehead, extending backwards over the greater part of the parietals, and the cheeks to the posterior margin of the eye, are of a dark brown color. The posterior part of the head is of a yellowish gray clay color, with the exception of two large, nearly triangular, black patches on the sides of the occiput. The light-colored stripe formed by the interspace between those two patches extends forwards to the parietals, nicking into the brown color. The

* Duméril et Bibron, Erpétologie générale, VII, p. 576 (1854).

back of the body is of a grayish clay color, with two rows of small ill-defined black spots, one on each side of the median line. These spots gradually become still less distinct backwards and disappear on the tail, which is more brown. On the sides some of the scales are dark-edged, particularly on the anterior part of the body. The belly is pale gray, with a dirty yellowish tinge. The sides of the gastrosteges are finely mottled with very small black dots.* The total length was 245 mm., the head and body 190 mm., and the tail 55 mm.

I wish to call attention to the fact that the number of scale rows of this specimen is 15, the same as in the one recently described by Dr. O. P. Hay† as *Storeria victa* from Oklawaha River, Florida, some distance to the north of Kissimmee. In other respects my specimen shows no special agreement with Hay's description or disagreement with that of typical *S. dekayi*. With only these two specimens thus far obtained in Florida the status of *S. victa* must remain doubtful, as it will require more material to decide whether the difference in the scale formula is constant or not.

STORERIA OCCIPITOMACULATA, (Storer).

Mr. S. Robinson, of Orlando, gave me, last April, a small red snake which he had caught at Oklawaha River, 10 miles southeast from Ocala, Marion County. The color of the living snake was as follows: Back, uniform dark red or "cherry-red;" belly, salmon or rather minium-colored; snout and anterior portion of head, brownish yellow; on the upper part of the neck a yellow half collar; tip of snout and chin, whitish; head underneath reddish, mottled with black; a narrow black mottled stripe on each side extends along the upper part of the gastrosteges, but becomes more and more faint posteriorly until it is no longer conspicuous 20 mm. behind the head; a small light spot on the fifth upper labial; mouth, brown; total length, 190 mm. In alcohol a faint light stripe extends from the yellow collar some distance backwards, but soon disappears. Although the color seems to be more brilliant than usual, I have no doubt it is a *Storeria occipitomaculata*, as the scutellation is the normal one of this species.

TANTILLA CORONATA, Baird and Girard.

In a rotten stump at Oakland I obtained a little *Tantilla*, and another one in the neighborhood of Apopka, Orange County. The last-mentioned is a typical *Tantilla coronata* in most respects, only the color is a little lighter than Baird & Girard describe it,‡ as it is light yellowish gray, with a faint brown tinge along the back; below, whitish; head, above dark brown with narrow yellowish collar. In this specimen the

*See HOLBROOK, J. E., North American Herpetology, 2 ed., IV, pl. XIV.

† Science, XIX, April 8, 1892, p. 199.

‡ BAIRD and GIRARD, Catalogue of North American Reptiles, I, Serpents, p. 131.

plates of the head are normal, except that the first pair of infralabials do not come in contact on the middle line, although very close together. The specimen from Oakland gave me at first much more trouble in classifying, as the prefrontals are completely fused with the preorbitals into one large plate on each side, extending down in front of the eye to the labials and separating the eye from the post-nasal. The color is the same as in the above-mentioned specimen. I take this to be only an individual variation.

ELAPS FULVIUS (Linnæus).

This is the only species of Elaps I have found in south Florida, where it is rather common. It is known under several names, as "coral snake," "American cobra," "garter snake," and "candy-stick." It is perhaps the most dangerous snake in Florida, because it is not so much dreaded as the big rattlesnake or moccasin, though being quite as poisonous. As the last-mentioned names show, it is regarded as a "pretty little snake." Few people know or believe that it is poisonous, it looks so harmless, and as a consequence they catch it and handle it rather roughly; the snake gets angry, bites, and a human life is endangered. I know personally of such a case. A Swede at Oakland, Orange County, found an *Elaps*, and because of its very beautiful color he caught it and tried to put it into a bottle of alcohol. The snake bit him, but the wound was not large, and as it did not swell he did not care much about it at first. After a while he was taken very sick, went to bed, asked for a physician, and drank whisky; but it was then too late. He died next morning, about 12 hours after the snake had bitten him. During the last hours he was unconscious, but before that he suffered most excruciating pains. I have heard of several other cases of boys dying from the effects of an *Elaps* bite.

In other cases people have been bitten by an *Elaps fulvius* without suffering from it in any way, but I suppose that in such cases the *Elaps* had not been able to inject any poison into the wound, as it has a rather small mouth. However that may be, I cannot agree with Cope* that the bite "of the smaller ones (meaning smaller species of *Elaps*) is innocuous to man and the larger animals." It is to be observed that the *Elaps* bites differently from the Crotalids and Viperids. The latter snake throws its head forward, in striking, and draws it back again immediately. The *Elaps fulvius*, I have seen and heard about, have acted in an entirely different manner. The poor Swede above mentioned had to *pull the snake from the wound*, and other specimens that I induced to bite into sticks kept the stick in the mouth for a good while. This habit probably signifies an intention to press as much poison as possible into the wound, which makes the snake the more dangerous. *Elaps fulvius* is, however, a good-natured snake, and it does

*Proc. U. S. Nat. Mus., XIV, 1891, p. 680 (1892).

not bite unless it is very much provoked. If not handled too roughly an *Elaps* may be allowed to crawl on one's hands from one to the other. I have allowed it myself once, but I hardly think I would do it over again, and would not advise anybody else to try it.

I have found *Elaps fulvius* under logs and digging in the ground as well as crawling about on the surface, but I think it prefers dry land.

The largest specimen I have seen was from Oakland, Orange County, and measured exactly 1 meter from the tip of the nose to the anus, and the tail was 90 mm. This big specimen had 14 black rings on the body and 3 on the tail. Other specimens have but 12 black rings on the body and 3 on the tail, but one of these has 4 on the tail. The yellow rings cover from one to two rows of scales.

SISTRURUS MILIARIUS (Linnæus).

The ground rattlesnake is not rare in south Florida. I have obtained specimens from different places in Orange and Hillsboro counties. The specimens from the latter place, near the Gulf coast, are darker and have no reddish brown between the black dorsal spots. The latteral spots, too, are larger and more distinctly black. Even the rattle is darker and larger, and the tip of the tail is not yellowish as in the others. The ground rattlesnake likes dry ground.

CROTALUS ADAMANTEUS, Beauvois.

In the interior of the country the diamond-backed rattlesnake is scarce, but not so along the coast and on some of the Florida keys. In the neighborhood of Ozona, in Hillsboro County, I heard of the killing of nine rattlesnakes within two weeks in October, 1892. It evidently prefers the neighborhood of the water, and is a good swimmer, not afraid to cross over from "key" to "key." If not too often disturbed this species is slow and does not rattle unless offended. I saw one in the latter part of October in the pine woods near Toronto, Orange County, coiled up under a palmetto bush. A dog following us went up and sniffed at him, with his nose hardly a foot from the snake. We called the dog back and a man ran forward with a whip and struck the snake several times. After the second blow the snake began to rattle and made himself ready to strike. This shows plainly the slow nature of the snake. In other cases they are more easily offended. Those kept in boxes and cages often begin to rattle as soon as they see anybody approaching. They are easy to keep alive and take food without trouble. I saw one that was kept in a small box and was fed with toads; it did so well there that it changed its skin twice in a summer. They are often kept in the shops of taxidermists and in "curiosity stores," where Northern tourists buy them, paying good prices. The skin is often used for ornaments or for the manufacture of pocketbooks and similar objects.

People are very seldom bitten by rattlesnakes in Florida. The rattling, the strong odor, and the slowness of the snake are protective.

This snake is often caught by placing an empty barrel over the coils, after which a board is shoved under the snake and the whole thing turned over.

AGKISTRODON PISCIVORUS (Lacépède).

"Moccasin," "Watermoccasin," "Stump-tail moccasin," and "Cotton-mouth moccasin" are the names by which this much-dreaded snake is known in south Florida. It is rather common where it has not been exterminated by man, and has been still more abundant around the lakes and in the swamps. It is a very ugly-looking animal, and very slow. It prefers to lie on the river banks, or on logs and stumps near the water. I once saw one on the St. John's River, at Lake Jessup, which had filled its lungs with air and basked in the sun, floating on the surface with the entire body out of the water. The young ones have brighter colors and are then sometimes mistaken for *A. contortrix*, the "Copperhead," but this snake is not found in Florida. I once caught a young moccasin which was being attacked by a butcher bird.

A very interesting fact which I have observed is that a moccasin, when it is angry and ready to bite, rattles with the tail like a rattlesnake. That other snakes have acquired this habit of scaring their enemies by making them believe that they are dangerous rattlesnakes is not so difficult to understand. But why does the moccasin rattle? That the rattling with the tail even by other snakes has something to do with the rattlesnake seems plain; for, why do not the non-American snakes rattle with the tail when excited? If the rattling only was something analogous to the playing with the tongue, why do not all snakes do it?

General remarks.

If we regard the Florida snakes observed by me, from a biographical point of view, under the heads of burrowing, climbing, crawling, and swimming species, the result may be tabulated as follows:

Burrowing species.

Cemophora coccinea.
Farancia abacura.
Osceola elapsoidea.
Stilosoma extenuatum.
Heterodon platyrhinos.
Tantilla coronata.
Elaps fulvius.
Total, 7 species.

Climbing species.

Opheodrys æstivus.
(*Bascanion constrictor*).
(*Callopeltis quadrivittatus*).
Total, 1 (+2) species.

Crawling species.

Lampropeltis getulus.
Diadophis punctatus.
Bascanion constrictor.
Bascanion flagellum.
Callopeltis guttatus.
Callopeltis quadrivittatus
Spilotes corais.
Pituophis melanoleucus.
Thamnophis sirtalis.
Thamnophis sackenii.
Storeria dekayi.
Storeria occipitomaculata.
Sistrurus miliarius.
Crotalus adamanteus.
Total, 14 species.

Swimming species.

Contia pygæa.
(*Farancia abacura*).
Liodytes allenii.
Natrix compressicauda.

Swimming species—Continued.

Natrix fasciata.
Natrix cyclopion.
Natrix taxispilota.
Agkistrodon piscivorus.
Total, 7 (+1) species.

It will be seen that there are as many burrowing species as there are water snakes, the light soil of Florida being very well adapted for subterranean life. Between the different categories there are, of course, no sharp limits.

The following species of snakes seem to be peculiar to Florida:

Contia pygæa, Cope.
Stilosoma extenuatum, Brown.
Callopeltis rosaceus (Cope).
Natrix usta, Cope.
Natrix compressicauda (Kennicott).
Thamnophis sackenii (Kennicott).
Liodytes allenii (Garman).

Of the genera of snakes, only *Stilosoma* and *Liodytes* appear to be peculiar.

BATRACHIA.

CAUDATA.

MANCULUS QUADRIDIGITATUS (Holbrook).

I have found this animal under old logs at the border of a small lake at Clarcona and at Lake John, and caught it in my dipnet in Fern Creek, near Orlando, Orange County. On land it is rather swift-running, and lives in localities similar to those which are frequented by *Leiolopisma laterale.* These two animals are also similar in color. Several of my specimens had well-developed cirri. One specimen in the U. S. National Museum (No. 21328).

DESMOGNATHUS AURICULATA (Holbrook).

I have only found one specimen of this species under a log in a wet hammock near Lake Jessup, Orange County. It is found in Georgia, but I do not know that it has been reported from Florida before.

DIEMYCTYLUS VIRIDESCENS, Rafinesque.

In a small but deep pond, with clear water and steep slopes all around, I caught a number of larvæ which, according to Dr. Stejneger's opinion, belong to this species. I have not seen it at any other place in Florida except in this pond, situated between Oakland and Lake John, in Orange County, but here many specimens were seen.

AMPHIUMA MEANS, Garden.

It is known under the name of "mud eel" or "mud puppy," and is not rare in Orange County, where I have caught specimens at Oviedo,

Apopka, and Orlando. People digging in the "muck" find them frequently in such soil, and I have taken them with my net in ponds and small lakes.

SIREN LACERTINA, Linnæus.

A man living at Oakland, Orange County, told me that he once had taken two specimens of the "*gray* mud puppy" on hook and line in Lake Apopka. I did not see any myself.

ECAUDATA.

BUFO LENTIGINOSUS, Shaw.

This is the most common toad in south Florida. It is seen in great numbers about the houses and other places in the evening. In the daytime it hides under old logs, boards, etc., at the shores of lakes and other moist places.

BUFO QUERCICUS, Holbrook.

This is a very active little animal considering the fact that it is a toad. It is seen in all kinds of places and at all times of the day, even in the brightest sunshine, but especially after rain. I have seen it very abundant on the dry sandhills about Oakland, Orange County, as well as in the "flatwood" about Kissimmee, Osceola County, and in Hillsboro County. The specimens from the latter place are a little different, as the frontal ridges are less prominent, straight behind, and the color of the back is redder.

ENGYSTOMA CAROLINENSE, Holbrook.

I have found this peculiar little animal under old logs, dry palm-leaves and such things, near lakes and in moist places in Orange County, for instance, in the pineland at Clarcona, and in the hammocks bordering Lake Jessup. It is not very common.

ACRIS GRYLLUS (Le Conte).

In south Florida, along the borders of ponds and swamps, this frog is abundant though not commonly seen. All my specimens show the triangular black spot on the head. The median dorsal stripe is always reddish brown, and I have never seen it green. The posterior femoral stripes are very conspicuous. The light stripe from the orbit to the axilla is constant, but the other blotches are not always light bordered.

HYLA SQUIRELLA, Latreille.

I take this to be the most common Hyla in south Florida. My specimens are from Hillsboro and Orange counties.

HYLA FEMORALIS, Latreille.

I obtained several specimens of this species in Orange County. I think it is the Hyla of the pine woods.

RANA CATESBEIANA, Shaw.

Very abundant in south Florida in ditches, ponds, swamps, and other wet places. It seems to like sluggish water and muddy bottom. My largest specimen was caught at Lake Eola, Orange County. It was when alive only 10 mm. smaller than the largest one in the U. S. National Museum, recorded by Cope.*

RANA PIPIENS, Schreber.

This is the most common frog in south Florida and is found everywhere in wet places. Some specimens come nearer to *R. p. sphenocephala*, others to typical *R. pipiens*, and it is difficult to draw any definite line. It is called "Spring frog." It has a great faculty of changing color between grass-green and brown. When it has turned green it is very beautiful.

RANA CLAMATA, Daudin.

Common near some ponds and small lakes in Orange County, but I could not catch any as they used to jump into the water with a cry long before I reached them.

RANA ÆSOPUS, Cope.

Of this species I have collected one specimen at Ozona, Hillsboro County. It was caught with hook and line in a small pond, and was called "snake frog" by the population there. I have seen it but rarely, and must conclude that it is either scarce or else that its habits are such as to prevent it from being observed. It agrees with Cope's description in every essential, but the throat is spotted with numerous elliptical or rounded spots of dark brown color. Two smaller specimens of the same kind were caught in Orange County, at Lake Jessup and Clarcona.

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* Bull. U. S. Nat. Mus., XXXIV, p. 426 (1889).

ON THE RODENTS OF THE GENUS SMINTHUS IN KASHMIR.

By FREDERICK W. TRUE,
Curator of the Department of Mammals.

ON AN earlier page of the present volume of the Proceedings,* I referred two specimens of *Sminthus*, collected in central Kashmir by Dr. Abbott, to the species recently described by Dr. Büchner,† under the name of *S. concolor*. I have since had access to Mr. Thomas' description of a new species (*S. leathemi*) from Wardwan,‡ and find it necessary to revise my previous statements. I am now of the opinion that Dr. Abbott's specimens should be regarded as distinct from both *S. concolor* and *S. leathemi*. It may be known from the following description:

SMINTHUS FLAVUS, new species.

Ears prominent. Tail one and one-half times as long as the head and body. Claws moderate. The thumb with an elongated convex nail.

Upper surfaces dull ochraceous gray, which color is produced by the mingling of the gray of the basal portion of the under fur, the ocher-color of its tips and the black ot the longer and coarser hair. On the sides the coarse black hairs become less and less abundant, leaving the color nearly pure ochraceous yellow. Upper lip and all under surfaces cream-white, the hair being of this color at the extremities and gray at the base. Sides and top of muzzle, and also the ears, chocolate-brown. Backs of the fore feet dusky brown; toes white. Hind feet entirely white. Tail bicolored, brown above and white below, except in the terminal 12 or 15 mm., where it is brown both above and below. Claws white.

Nasal bones of the skull long. Interparietal a little more than twice as wide as long. Incisive foramina ending posteriorly opposite the middle of the premolar. Posterior extremity of the palate on a line with the hinder margin of the last molar, and furnished with a median spinous projection.

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* Proc. U. S. Nat. Mus., XVII, 1894, p. 9.

† Bull. Acad. Sci. St. Petersburg, new ser., III, 1892, p. 107.

‡ Ann. and Mag. Nat. Hist., 6th series, XI, 1893, p. 184.

Upper premolar a little broader than long. Last molar larger than the premolar, the crown forming an equilateral triangle with convex sides. First upper molar with two outer and two inner cusps, and a small anterior one. Second upper molar with four cusps. Last lower molar elongate.

Dr. Abbott's measurements of one of the skins (No. $\frac{20140}{35503}$, ♂, type) are as follows: Head and body, $2\frac{3}{4}$ inches (69.8 mm.); tail, $4\frac{1}{4}$ inches (107.9 mm.). The ear, measured from the base of the outer margin, is 12.5 mm. long.

Dimensions of skull of type specimen.

Skull.	Length in millimeters.
Greatest length	21.3
Basilar length (Hensel)	16.0
Zygomatic breadth	10.0
Interorbital breadth	4.5
Length of nasals	8.5
Length of interparietal	2.5
Breadth of interparietal	7.0
Length of palate	8.3
Length of palatine foramina	4.6
Length of upper molar series	3.2

This species differs from *S. subtilis* in the absence of the black dorsal line and the greater length of the tail. I have no skulls of the latter species at command, but from Brandt's figure* and the remarks made by Mr. Thomas in connection with his description of *S. leathemi*, it appears that *S. subtilis* has the palate much prolonged posteriorly, which is not the case in the species herein described.

From *S. concolor*, Büchner,† the present species differs in the buffy color of the sides of the body and head, the white under surfaces, the brownish fore feet, the white claws, and the coloration of the tail. The whiskers are longer than in *S. concolor*. The upper premolar and last molar are in line with the other molars; and the last molar is also elongated. The nasals are longer. Whether the characters of the palate are the same in *S. concolor* and the species herein described can not be determined at present, as Dr. Büchner makes no mention of this part of the skull.

From the species described by Mr. Thomas, under the name of *S. leathemi*, the present species appears to differ in the yellowish, rather than rufous, coloration of the body, the brown color of the backs of the fore feet, and the uniform brown color of the extremity of the tail on both upper and under surfaces.

Mr. Thomas gives the length of the ear in *S. leathemi* as 8.3 mm., but as he does not specify from what points the measurement is taken it is impossible to say whether the ear in *S. flavus* is shorter or longer,

* BRANDT, J. F.—Untersuch. Craniolog. Entwickelungsstufen der Nager, pl. ii, figs. 15–21.

† The description of this species was not at hand when I revised my article on Dr. Abbott's Kashmir collection for publication, and I was led into the mistake of regarding the Chinese and Kashmir species as identical.

though it appears to be the latter. The length from the base of the outer margin is about 12.5 mm., which is practically the same length as in *S. concolor*.

The tail is approximately of the same length in *S. flavus* and *S. concolor*, or about one-half longer than the head and body. This proportion is much exceeded in *S. leathemi*, which has the tail one and four-fifths times the length of the head and body.

Dr. Abbott's two specimens were obtained in central Kashmir, at an elevation of 11,000 feet, in July, 1891, about a year earlier than the types of *S. leathemi* were collected. To Dr. Abbott, therefore, is due the first discovery of representatives of this interesting genus in British India.

THE RELATIONSHIP OF THE LACERTILIAN GENUS ANNIELLA, GRAY.

By G. BAUR, PH. D.
Assistant Professor of Paleontology, University of Chicago.

THE GENUS *Anniella* was created by Gray* in 1852. It was based on a specimen collected by J. O. Goodridge, Surgeon R. N., in California, and placed among the Scincidæ, section Siaphosinæ, near *Soridia lineata*, Gray (*Lygosoma præpeditum*, Boulenger). The species was called *Anniella pulchra*, Gray.

In 1864 Prof. E. D. Cope† established a special family for this genus under the name of Anniellidæ, which, together with the Anelytropidæ and Acontiidæ, was placed in the tribe Typhlophthalmi.

The characters given were the following:‡

TYPHLOPHTHALMI.

Temporal bone [squamosal] superior plate elongate.
Arches incomplete or wanting.
Articular and angular confluent. Suspensoria one or two.
Dentary, inferior process elongate.
Premaxillary single or double.
Clavicles very slender, transverse rudimentary or wanting.
Mesosternum and other sternal pieces wanting.
Tongue squamous or papillose, simple.—ANELYTROPIDÆ, ACONTIIDÆ, ANIELLIDÆ.

The families of the tribe Typhlophthalmi were thus characterized:

α Two suspensoria; nostril in the rostral shield. Tongue squamous.
Eye concealed by epidermis; occipital segment loosely attached. No frontal underarch .... ANELYTROPIDÆ
Eye distinct; occipital closely articulated; two premaxillaries .... ACONTIIDÆ
β One suspensorium; nostril in a nasolabial plate; tongue papillose.
Eye distinct; occipital closely articulated; one premaxillary; an inferior frontal arch .... ANIELLIDÆ

*GRAY, J. E.—Descriptions of several new genera of reptiles, principally from the collection of H. M. S. *Herald*. Ann. Mag. Nat. Hist., 2 ser., x, 1852, p. 440.

†COPE, E. D.—On the characters of the higher groups of Reptilia Squamata and especially of the Diploglossa. Proc. Acad. Nat. Sci. Philadelphia, 1864, pp. 228–230.

‡I have to thank Dr. Leonhard Stejneger for a copy of these notes, the Proceedings of the Philadelphia Academy being not at hand.

The Anelytropidæ contain *Typhlosaurus*, *Feylinia*, (and *Anelytrops*); the Acontidæ the genus *Acontias;* the Anniellidæ the genus *Anniella*. Cope continues:

The remarkable genus Anniella lacks the squamosal [quadratojugal] and columella, and has a single premaxillary. The parietal is continuous with the superior plate of the temporal [squamosal], and is much decurved toward the sphenoid; the frontal encloses the olfactory lobes below; these characters are the most amphisbænian in the order. There are small pre- and postfrontal bones, and a slender ligamentous postorbital arch. I have as yet found no sternal pieces, and the splenio-mental groove is closed, as in Acontias.

The same view is held by Cope* in 1871 and 1875.

Boulenger† in 1884 adopted the families Anniellidæ and Anelytropidæ, but united the Acontiidæ with the Scincidæ.

The Anniellidæ are placed between the Anguidæ and Helodermatidæ, and the following characters are given:

No interorbital septum, no columella cranii, no arches.

The year following the family was characterized thus: ‡

Teeth large, few, fang-like, with short swollen base. Palate toothless. Skull approaching the Ophidian type, i. e., lacking the præsphenoidal vacuity and consequently the interorbital septum, and the bones which constitute the brain-case firmly united; no columella cranii, no squamosal; postorbital arch ligamentous; pterygoids in contact with sphenoid; an infraorbital fossa; præmaxillary single; nasal and frontal divided; parietal single; præ- and postorbital in contact, separating the frontal from the border of the orbit; scales soft.

Of Anniella, he says:

It appears to be a strongly degraded form of the Anguidæ, similarly as the Anelytropidæ and Dibamidæ are to the Scincidæ.

Gill,§ reviewing Boulenger's classification of the Lacertilia, places the Anniellidæ in a superfamily Annielloidea, between the Helodermatidæ and Anguidæ.

Shortly after, Cope ‖ created for the Anniellidæ a special suborder, Anguisauri, which he placed after the Typhlophthalmi, in a special group, including the Opheosauri (Amphisbænians). The characters of this group were given as "Prootic bone produced beyond arched body; one suspensorium (=opisthotic [squamosal]) wanting; pelvic arch rudimentary or wanting," and the characters of the Anguisauri: "Frontal bone underarching olfactory lobes; supraoccipital gomphosis internal,

*Cope, E. D.—On the homologies of some of the cranial bones of Reptilia and on the systematic arrangement of the class. Amer. Assoc. Adv. Science, XIX, 1871, p. 237.

Cope, E. D.—Check-list of North American Batrachia and Reptilia. Bull. U. S. Nat. Mus., I, p. 44. 1875.

† Boulenger, G. A.—Synopsis of the families of the existing Lacertilia. Ann. Mag. Nat. Hist. (5), XIV, London, 1884, pp. 117–122.

‡ Boulenger, G. A.—Catalogue of Lizards in the British Museum, II, pp. 299–300.

§ Gill, Th.—Annual Report of the Board of Regents of the Smithsonian Inst. to July, 1885, Part I, pp. 799–801. 1886.

‖ Cope, E. D.—Catalogue of the Batrachians and Reptiles of Central America and Mexico. Bull. U. S. Nat. Mus., XXXII, 1887, pp. 25–26.

no orbitosphenoid." Nothing is added to the family characters of the Anniellidæ.

The same view is held in 1889* and in 1891.† Gill's name Anielloidea is substituted for Anguisauri.

In 1892 Cope ‡ gave a description of the osteology of Anniella, figuring the skull, hyoid and pelvic arch, and reaches the following conclusion:

> The further knowledge of its [Anniella's] structure brings out more clearly its true position. This is, I think, in the Annulati or Amphisbænia. The characters which indicate this reference are: (1) The continuity of the parietal with the petrosal and supraoccipital elements. (2) The absence of epipterygoid. (3) The absence of ceratohyal elements. (4) The hypophyses of the cervical vertebræ, which are continuous with the centra. (5) The partially open chevron bones, which are also continuous with the centra. (6) The sublongitudinal ileopectineal bone and absence of other pelvic elements.

He now places the Anniellidæ as a very distinct family among the Amphisbænia.

We have therefore the following views in regard to the systematic position of Anniella:

1852. Gray: *Anniella* belongs to the Scincidæ and is closely related to Soridia lineata, Gray.

1864, 1871, 1875. Cope: *Anniella* is the representative of a special family Anniellidæ, which, together with the Anelytropidæ and Acontiidæ, forms a special tribe of the Lacertilia.

1884, 1885. Boulenger: The *Anniellidæ* form a family between the *Anguidæ* and *Helodermatidæ*; Anniella seems to be a strongly degraded form of the *Anguidæ*.

1886. Gill: The *Anniellidæ* have to be placed in a distinct superfamily *Anniel-loidea*, between the *Anguidæ* and the *Helodermatidæ*.

1887, 1889. Cope: The *Anniellidæ* belong to a special suborder *Anguisauri;* the *Anguisauri* and *Opheosauri* (Amphisbænia) constitute a natural group of the Lacertilia.

1891. Cope: The name *Annielloidea*, Gill is substituted for *Anguisauri*.

1892. Cope: The *Anniellidæ* form a very distinct family of the *Amphisbænia*.

Having lately been engaged in a detailed study of the morphology of the skull of the Amphisbænians, of which I shall report in another place, it became necessary to examine *Anniella*, which, according to Cope's latest researches, is considered a member of the Amphisbænians. My material consists of 2 skulls prepared by myself from alcoholic specimens, which were given me by Prof. J. J. Rivers, of Oakland, Cal., and of a completely macerated skeleton of *Anniella pulchra*, (No. 3185, U.S.N.M.), from San Diego, Cal., collected by Dr. J. L. Le Conte. I

* Cope, E. D.—Synopsis of the families of Vertebrata. Am. Nat., Oct., 1889, pp. 19-20.

† Cope, E. D.—Syllabus of lectures on Geology and Paleontology. Philadelphia, 1891, p. 48.

‡ Cope, E. D.—The Osteology of the Lacertilia. Proc. Amer. Philos. Soc., XXX, May 10, 1892, pp. 215-217, Pl. II, fig. 4; Pl. VI, fig. 43.

Cope, E. D.—On Degenerate Types of Scapular and Pelvic Arches in the Lacertilia. Journ. Morphol., VII, No. 2, p. 240, Pl. XIII, fig. 7. Boston, 1892.

am indebted to Prof. Rivers and Dr. L. Stejneger for the great kindness they have shown me, by furnishing these valuable specimens.

From the study of this material, I reach the following conclusion: *Anniella* has to be placed in a separate family, very close to the Anguidæ, and has its closest relative in *Anguis* itself. Boulenger's opinion is nearest to the truth. Reasons: (1) There is a distinct epipterygoid (columella). (2) There is a well-developed squamosal [supratemporal, Parker and Bettany, Cope]; but the quadrato-jugal [paroccipital, Cope] is absent. (3) The jugal is present, but rudimentary at its upper end, being connected with the postorbital by ligament only. (4) The lachrymal is present. (5) There is a well-developed supraorbital. (6) The caudal vertebræ are segmented, the segmentation being placed in the anterior portion of the centrum. (7) Osteodermal plates are present.

I shall now give a description of the skull and the other most important elements of the skeleton, from which it will be evident that my opinion about the relationship of Anniella is the only one which agrees with the facts. Figures will be published in a paper, now in preparation, "On the morphology of the skull of the Amphisbænia."

OSTEOLOGICAL CHARACTERS OF ANNIELLA.

The skull.—The præmaxillary is single, sending a median process between the nasals. There are three processes on the lower side; one median, two lateral ones. The median process extends between the anterior ends of the vomer; the lateral processes are connected with the maxillaries, by which they are embraced on the outer side. The nasals are distinct; they are in connection with the præmaxillary, frontals, maxillaries; they are separated above from the prefrontals by a very slender anterior process of the frontals. There are two frontals, in connection with the nasals, prefrontals, postfrontals, and parietals; the descending processes are strong and meet below, underarching the olfactory lobes. The parietal is single and very large; it is in connection with the frontals, postfrontals, petrosals, squamosals, paroccipitals, and supraoccipital. There is no pineal foramen; but the dark pineal eye is quite distinct in the anterior portion of the parietal, and the pineal fossa is present on the lower side of the parietal. The parietals are bent down strongly. There are two small processes behind close to the median line. The outer and posterior ends of the parietal show short processes, which are placed on the petrosals, and on which the anterior end of the squamosal rests. The supraoccipital is closely united by suture with the parietal. There is a median process and two lateral processes, on each side of the median, all united with the parietal. Two very small vacuities between parietal and supraoccipital, close to the median line, are present. The supraoccipital is connected, besides, with the exoccipitals, paroccipitals, and petrosals. The foramen magnum is bordered by the basioccipital, exoccipitals, and supraoccipital. The condyle is convex, quite simple, and formed by the basioccipitals and exoc-

cipitals. In one of the specimens before me, the sutures between these elements are quite distinct, also the suture between the basioccipital and basisphenoid. The paroccipital processes of the exoccipital are broad, not much developed, connected on the outside with the squamosal and parietal, and touching the posterior slender process of the quadrate. The basisphenoid sends processes on each side backwards, over the basioccipital, joining the epiphyseal process between basioccipital and basisphenoid. The basipterygoid processes of the basisphenoid are well developed. The petrosal shows a long anterior process, which nearly reaches the epipterygoid. The maxillary is in connection with the premaxillary, nasal, frontal, prefrontal, supraorbital, lachrymal, jugal, ectopterygoid, vomer, and palatine. There are 5 maxillary foramina, 2 above and 3 below; the number of teeth is 7, and they show a groove on the anterior and inner side at the top. The prefrontal* is slender, placed along nearly the whole lateral border of the frontal, separated from the parietal only by a slender posterior outer process of the frontal; the descending process of the prefrontal is well developed. The prefrontal is in connection with frontal, supraorbital, palatine, and postfrontal. The postfrontal is small, in connection with frontal and parietal, and the very small postorbital, which is attached to it at its posterior and lower end. The frontal is therefore completely excluded from the orbit; a condition which is found also in *Chamæleo*, *Heloderma*, *Pygopus*, and in *Trachysaurus*, *Tyliqua* of the Scincidæ.†

The supraorbital is a large bone, placed above the eye in the anterior region of the orbit; it is in connection with the prefrontal and maxillary as in *Anguis*. The lachrymal is very small, in connection with maxillary, jugal on the outside, and the prefrontal on the inside. The jugal is a slender element; it becomes ligamentous in its upper posterior portion, where it joins the postorbital. It is in connection with maxillary, lachrymal, and ectopterygoid.‡ The conditions of these elements are very much like those seen in *Anguis*.

The squamosal [opisthotic, paroccipital, Cope; supratemporal, Parker and Betany; mastoidien, Cuvier] is a small splint-like bone, standing on the quadrate and connected with the parietal, paroccipital, and touching the petrosal. There is no trace of a quadratojugal (squamosal, Parker; supratemporal, Cope).§

*Cope says—"The prefrontal is above the eye, and is cut off from the postfrontal by an entrant angle only." Osteol. Lacert., p. 215. Instead of postfrontal it ought to read parietal.

†SIEBENROCK, FRIEDRICH—Zur Kenntniss des Kopfskelettes der Scincoiden, Anguiden und Gerrhosauriden. Ann. K. K. Naturhist. Hofmus., VII, 3, p. 181, Wien 1892.

‡The description of these elements and the figures given by Cope are not correct. He states, p. 186, that the jugal in Anniella may include the lachrymal; and, p. 215, "No jugal." No mention is made of the supraorbital. In the drawing it seems to be indicated, but the prefrontal is not figured. All the drawings given on Pl. II are very poor and quite useless.

§Cope states—No distinct supratemporal [quadratojugal] or paroccipital [squamosal].

The stapes has a very large disc and a short columella; it is placed between the paroccipital, petrosal, and basioccipital.

The vomers are united in the median line, at about three-fourths of their length; posteriorly they diverge. In the middle they show a deep groove, which is bordered on each side by a keel placed on each vomer. Each vomer is pierced by a foramen. In front they are united with the præmaxillary, outside with the maxillaries, and behind with the palatines. The maxillary processes are well developed and cover partially the posterior nares. The palatines are separated in the middle line; they are in connection with the vomers, maxillaries, ectopterygoids, pterygoids, and prefrontals. The pterygoids are completely separated from each other. They show three processes, one posterior one attached to the inner side of the quadrate and extending a little behind its posterior border. This process is deeply hollowed out at its lower and inner side. Two processes are directed in front; the inner broad one is connected with the palatines, the outer slender one with the ectopterygoids. The foramen ectopterygoideum (suborbitale) is bound by pterygoid, ectopterygoid, and palatine. The quadrate is simple, hollowed out somewhat externally; it shows a distinct upper and posterior process, which extends above the stapes to the paroccipital and supports the squamosal. The epipterygoid, which was stated to be absent by all authors in *Anniella*, is present; it is a slender, short columellar ossicle, which stands vertically on the pterygoid and nearly reaches the descending process of the parietal. The mandible consists of 5 pieces, articular and supra-angular being ossified. There are 7–8 teeth, which also show the grooves. The hyoid system is very simple, and has been correctly described by Prof. Cope. It consists of a single glosso-basihyal, which is divided behind, and gives attachment to a very slender first hyobranchial; more slender than figured by Cope.

The vertebræ.—There are 74 presacral vertebræ in two specimens examined by me; 73 in Prof. Cope's specimen. All of these bear ribs, with exception of the two first ones. One specimen had even a cervical rib on the second vertebra, but only on one side. The seventy-fifth vertebra has a simple sacral rib united with the centrum; the seventy-sixth vertebra has the sacral rib distally split, forming a lymphapophysis; the seventy-seventh is of the same form and shows the first chevron, the lateral pieces being not united distally; the seventy-eighth shows only on the right side an indication of splitting at the distal end of the transverse process; the chevrons are not united distally; the seventy-ninth exhibits single caudal ribs, and the chevrons are united distally. At the eighty-first vertebra the transverse splitting of the centrum commences; the split is in the anterior portion of the centrum and cuts off a small anterior portion of the caudal rib. Cope erroneously states the caudal vertebræ are not segmented. I consider the seventy-fifth and seventy-sixth vertebra as the true sacrals, to one of which the rudimentary pelvic arch is attached by ligaments. The

chevrons are placed centrally. There are ten "cervical" vertebræ, showing lower processes, which are placed in the center and contain both catapophyses* and intercentra.

The neural spines are developed in the tail, but very little; in the dorsal region they are short, vertical ridges, which are somewhat more developed in the cervical region.

The shoulder girdle and pelvis.—No trace of a shoulder girdle could be found. The pelvis was represented not only by a rudimentary ileum, as stated by Cope, but also by an ischium and pubis, which are united proximally. The pubis has an obturator foramen. These bones I only found in the macerated skeleton.

Dermal ossifications.—By all authors it is stated that dermal ossifications in the skin are absent; this is not correct; they are well developed.

I now give the osteological characters of the family Anniellidæ: Teeth large, few, fang-like, with short, swollen base, and indications of grooves. Palate toothless. Skull approaching the Amphisbænian type; no interorbital septum; parietals suturally united with supraoccipital; petrosal greatly produced in front; an epipterygoid; squamosal present, but small; quadratojugal absent; postorbital arch ligamentous; a supraorbital bone; pterygoids not in contact with basicranial axis, except by the basipterygoid processes; an infraorbital fossa; præmaxillary single; nasal and frontal divided; parietal single; præ- and postfrontal in contact. Caudal vertebræ segmented; osteodermal plates.

The Anniellidæ are in the same relations to the Anguidæ, as are the Acontiidæ to the Scincidæ; but they are still more degenerated, for in the Acontiidæ we still find a very rudimentary quadratojugal.

I shall discuss the relationship of all these degenerate families more fully in my paper on the Amphisbænia.

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* I call catapophysis the lower process in the cervicals, to which the intercentra (hypapophysis) are attached; the lower processes in the vertebræ of snakes, for instance, are catapophyses and not hypapophyses.

DIAGNOSES OF SOME UNDESCRIBED WOOD RATS (GENUS NEOTOMA) IN THE NATIONAL MUSEUM.

By Frederick W. True,
Curator of the Department of Mammals.

The following diagnoses were drawn up in connection with a study of the Wood Rats of the United States, in the National Museum, which I have recently completed. It is my intention to publish further descriptions of these forms, together with notes on other species which inhabit the United States, in a subsequent paper.

NEOTOMA SPLENDENS, new species.

Size of *N. fuscipes;* tail as long as the head and body. Ears large, moderately clothed with long hairs.

Upper surfaces tawny, shaded with black, especially along the spine. Sides clearer tawny-brown. Head more or less grayish. Throat, breast and space between the hind legs white, the hairs being of this color throughout. A line on the lower sides of the cheeks, the sides of the breast, and the whole belly more or less bright tawny-buff, which color is continued on the flanks. Tail unicolor, black throughout, as in *N. fuscipes*. Fore feet white; hind feet dusky to the toes. Ears dusky

Skull (No. 24231, U.S.N.M.), with the nasal processes of intermaxillæ not extending greatly beyond the nasals posteriorly (about 2 mm.). Incisive foramina long, reaching to the line of the anterior molar. Palate ending posteriorly in two small capsules, with an emargination between them. Anterior palatal spine straight. Interparietal narrowly pentagonal, without an angle behind.

Dimensions of type (No. 19693, U.S.N.M., male).*—Total length, 438 mm.; tail, 215 mm.

Dimensions of skull (No. 24230, U.S.N.M.).—Total length, 47 mm.; basilar length (Hensel), 38; zygomatic breadth, 24.2; length of nasals, 17.6; length of incisive foramina, 10.

Type.—No. 19693, U.S.N.M., male, Marin County, Cal. Collected November 25, 1887.

* Collector's measurements.

Proceedings of the U. S. National Museum, Vol. XVII, No. 1006.
[Advance sheets of this paper were published June 27, 1894.]

NEOTOMA MACROTIS SIMPLEX, new subspecies.

Similar to *N. macrotis*, but all the under surfaces and the feet white, the hairs being of this color to the roots. Tail rather sharply bicolored. Ears very thinly clothed with whitish hairs.

Skull as in *N. macrotis*, but the extremity of the anterior palatal spine touches the vomer.

Dimensions of the type (No. 3651, U.S.N.M.).*—Head and body, 213 mm.; tail vertebræ, 167; hind foot (without claw), 35; ear, from orifice, 27.

Dimensions of skull (No. 3598, U.S.N.M.).—Total length, 48 mm.; basilar length (Hensel), 38; zygomatic breadth, 24.3; length of nasals, 18.5; length of incisive foramina, 9.5.

Type.—No. 3651, U.S.N.M., Fort Tejon, Cal. Collected by J. Xantus.

NEOTOMA VENUSTA, new species.

Size moderate Ears large and thin. Tail as long as the head and body.

Upper surfaces mingled buff and pale gray. Sides clearer buff, sharply marked off from the color of the under surfaces, which together with the feet are pure white. Hairs white to the base on the throat, sides of cheeks, breast, inside of fore legs, inguinal region, and feet. A tuft of pure white hairs at the base of the outer margin of the ears. Ears thinly clothed with long, whitish hairs. Tail gray above, pure white below.

Skull thick and massive. Nasals shorter than the intermaxillæ and much contracted posteriorly. Interparietal large, with a convex posterior margin. Incisive foramina short and broad, reaching posteriorly about to the line of the molars. Tympanic bullæ large. Foramen magnum low and wide. Posterior termination of palate concave.

Incisors very broad and convex. Molars long and broad.

Dimensions of the type (No. $\frac{21696}{36400}$, U.S.N.M.).†—Total length, 364 mm.; tail, 173; hind foot, 35.

Dimensions of the skull of type.—Total length, 43 mm.; basilar length (Hensel), 36; zygomatic breadth, 23.4; length of interparietal, 6.2; length of incisive foramina, 8.2; length of molars (alveolæ), 9.4; breadth of incisors, together, 4.0; breadth of foramen magnum, 7.5.

Type.—No. $\frac{21696}{36400}$, male, Carrizo Creek, California. Collected by F. Stephens.

NEOTOMA OCCIDENTALIS FUSCA, new subspecies.

Back blackish, sides tawny-gray, belly soiled white. Under side of neck tawny-gray. A small area of entirely white hairs between the fore legs. Upper portion of legs gray both above and below. Fore

* From the dry skin.

† Collector's measurements.

feet white. Hind feet with the proximal half of the metatarsus, and also the base of the toes, dusky. Tail black above, buffy-gray below. Ears dusky.

(Skull wanting.)

Dimensions of the type (a dry skin, No. 3370, U.S.N.M.).—Head and body, 215 mm.; tail vertebræ, 180; hind foot (and claw), 44.

Type.—No. 3370, U.S.N.M., Fort Umpqua, Oreg. Collected by E. P. Vollum.

Dr. Merriam has recently stated* that the skulls of the bushy-tailed Wood Rats, which constitute the genus *Teonoma* of Gray, are without vacuities at the sides of the presphenoid, and regards this as a character of importance. The bushy tailed species of the Rocky Mountains (*N. cinerea*), however, has large vacuities. They are absent only in *N. occidentalis* and its varieties. Hence this character is not correlated with the condition of the tail. There is, furthermore, much variation in the size of the vacuities in the scaly-tailed species, those of *N. floridana* and varieties being very small.

A *Neotoma* from Fort Liard, British America, has the skull similar to *N. occidentalis*, and Richardson's *N. drummondi* is perhaps a variety of this species, with no close relationship to *N. cinerea* of the Rocky Mountains of the United States.

* Proc. Biol. Soc. Washington, VIII, p. 112, 1893.

DESCRIPTIONS OF TWENTY-TWO NEW SPECIES OF BIRDS FROM THE GALAPAGOS ISLANDS.

By Robert Ridgway,
Curator of the Department of Birds.

The very large and valuable collection of Galapagos birds made by Dr. G. Baur and Mr. C. F. Adams, in 1891, was referred to me for determination of the species soon after the return of those gentlemen from their highly successful exploration of that remarkable island group, but various circumstances have prevented an earlier publication of the results of my study of the collection. Many of the specimens having been obtained on islands never before visited by a collector, it is to be expected that novelties would be found among the rich material which it has been my privilege to study. One box containing more than one hundred specimens of small birds collected on Charles, Hood, Barrington, and South Albemarle islands was unfortunately stolen at Guayaquil. Had these specimens been received, there can be no doubt that the number of new forms to be here characterized would be still greater.

Perhaps the most interesting result of Messrs. Baur and Adams' explorations is the discovery of species which absolutely bridge the previously existing gap between the so-called genera *Geospiza* and *Cactornis*, thus necessitating the suppression of one of these names (the latter, according to the rule of priority). This matter will be fully discussed and illustrated in a much more detailed paper which will be published as soon as practicable.

1. NESOMIMUS BAURI, new species.

Specific characters.—Similar to *N. personatus*, Ridgway* of Abingdon Island, but much lighter colored above. Dimensions averaging less, and flanks more narrowly streaked with dusky; wing, 4.30–4.45; tail, 3.95–4.30; exposed culmen, 0.95–1; bill from rictus, 1.25–1.27; tarsus, 1.25–1.35; middle toe, 0.78–0.85.

Habitat.—Tower Island (type in Dr. Baur's collection, Sept. 2, 1891).

*Proc. U. S. Nat. Mus. XII, No. 767, p. 104, February 5, 1890 (Abingdon Island, Galapagos).

In coloration of the upper parts this form resembles *N. melanotis* much more than *N. personatus;* otherwise, however, it is easily distinguished, the bill being much larger (sometimes quite as large as in smaller-billed examples of *N. personatus*), the light-colored tips to middle wing-coverts much wider, white terminal spots of rectrices smaller and differently shaped, and dusky streaks much narrower.

Three specimens are in Dr. Baur's collection.

2. NESOMIMUS BINDLOEI, new species.

Specific characters.—Similar to *N. bauri*, Ridgway, but smaller and with proportionally longer tarsus; ear-coverts solidly black, tips to lesser wing-coverts paler (usually nearly white on posterior row), and white on rectrices more extended. Wing 3.85–4.20; tail, 3.50–390; exposed culmen, 0.83–0.91; bill from rictus, 1.15–1.20; tarsus, 1.32–1.39; middle toe, 0.75–0.81.

Habitat.—Bindloe Island (type in Dr. Baur's collection).

Five specimens, all separable from *N. bauri* by the above-mentioned characters.

3. NESOMIMUS ADAMSI, new species.

Specific characters.—Similar to *N. macdonaldi*, Ridgway,* in color, but very much smaller, and differing in some respects as to coloration.

Habitat.—Chatham Island. (Type in Dr. Baur's collection; ♂ ad., Chatham Island, June 13, 1891.)

This very distinct species, while about the size of *N. melanotis*, clearly belongs to the same group as *N. macdonaldi*, having the same brownish gray band across the chest and broken belt of dusky spots across the lower breast. The ear coverts are more extensively and solidly black than in that species, nearly as much so as in *N. melanotis*, which perhaps has caused it to be referred to that species. The white tips to the outer rectrices are much more extensive and more abruptly defined than in *N. macdonaldi*, being very much as in *N. melanotis*.

Compared with 16 specimens of *N. melanotis* from James Island, the 11 adults of the present species from Chatham Island differ in the much lighter color of the pileum, the ground color of which is brownish gray relieved by mesial streaks of blackish, which never, at any season, equal the gray in extent; the feathers of the dorsal region are much more broadly edged with gray, and the lower parts are markedly different, as described above.

4. CERTHIDEA SALVINI, new species.

Specific characters.—Similar to *C. olivacea*, Gould, but much yellower below, the upper parts more decidedly and uniformly olivaceous, under parts much more yellowish, and the bill larger; adult male with throat, etc., ochraceous-buff instead of tawny.

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*Proc. U. S. Nat. Mus. XII, No. 767, p. 103 February 5, 1890 (Hood Island, Galapagos).

Habitat.—Indefatigable Island, Galapagos Archipelago.

Adult male (Type, No. 438, coll. Dr. G. Baur, Indefatigable Island, August 6, 1891).—Above brownish olive (decidedly browner than *C. olivacea*), the pileum and hind-neck quite uniform with the back, etc., but the rump and upper tail-coverts brighter, more tinged with tawny-olive; wings and tail dusky, the feathers edged broadly with the color of the back, inclining on greater wing-coverts to wood-brown. Supraloral streak, orbits, chin, and throat, soft ochraceous-buff, the latter slightly mottled with buffy whitish; rest of under parts pale buff-yellow, deepening on sides and flanks into a more brownish tint. Upper mandible, dark brown; lower, brownish white; "iris, dark brown;" legs, dark horn-brown; feet, dusky; length (skin), 3.60; wing, 2.10; tail, 1.38; exposed culmen, 0.40; tarsus, 0.81; middle toe, 0.48.

Females and immature males are much more olivaceous above than those of *C. olivacea*, and the under parts are conspicuously more yellowish.

All of the seven examples, two of which are in the National Museum collection, have the under mandible pale brown or whitish.

5. CERTHIDEA BIFASCIATA, new species.

Specific characters.—Most like *C. cinerascens*, Ridgway,* of Hood Island, but still whiter (entirely almost pure white) beneath, and wing with two broad, whitish bands across tips of greater and middle coverts.

Habitat.—Barrington Island, Galapagos.

Adult (type, No. 593, coll. Dr. G. Baur, Barrington Island, July 9, 1891).—Above brownish gray, becoming very much paler on the rump; wings and tail dusky, the feathers broadly edged with grayish brown; middle wing-coverts broadly tipped with pale, dull buffy, and greater coverts with dull white, producing two conspicuous bands across the wing. Lores, orbits, cheeks, and entire under parts uniform dull white. Upper mandible dark brown, edged with whitish; under mandible whitish; legs and feet brownish black. Length (skin), 3.40; wing, 2; tail, 1.40; exposed culmen, 0.40; tarsus, 0.78; middle toe, 0.48.

Three specimens from Barrington Island agree in the above characters.

6. CERTHIDEA MENTALIS, new species.

Specific characters.—Similar to *C. fusca*, Sclater and Salvin, of Abingdon Island, but rather smaller, color darker and less olivaceous, the under parts dull light olive-grayish, becoming pale buffy on chin and under wing-coverts.

Habitat.—Tower Island, Galapagos.

Adult (type, No. 594, coll. Dr. G. Baur, Tower Island, Sept. 2, 1891).—Above uniform deep grayish olive; chin, throat, and under wing-coverts pale buff, deepest on chin, that of throat changing gradually on chest

*Proc. U. S. Nat. Mus., XII, No. 767, p. 105, Feb. 4, 1890.

to buffy gray, which covers whole chest, upper breast, sides, and flanks; belly dull whitish; under tail-coverts buffy white. An indistinct whitish supraloral streak. Wing, 2.05; tail, 1.58; exposed culmen, 0.40; tarsus, 0.80.

There are five specimens in Dr. Baur's collection, one of which has the under mandible apparently black, one dark brown, the other three brownish white.

7. CERTHIDEA ALBEMARLEI, new species.

Specific characters.—Similar to *C. olivacea*, Gould, of James and Jervis islands, but under parts nearly clear pale buff, and tips of middle and greater wing-coverts deeper rusty.

Habitat.—Albemarle Island, Galapagos.

Adult? (type, No. 595, coll. Dr. G. Baur, Albemarle Island, July 21, 1891).—Above uniform dull grayish brown, slightly tinged with olive; wings and tail dusky, the feathers broadly edged with the color of the back; middle and greater wing-coverts rather broadly tipped with cinnamon; under parts cream-buff, paler on belly, more brownish on sides and flanks. Upper mandible light brown, darker on culmen; lower mandible brownish white; tarsi pale horn-color, toes somewhat darker. Wing, 2.05; tail, 1.45; exposed culmen, 0.40; tarsus, 0.83.

Another specimen from Cowly Bay, East Albemarle (August 10), is quite like the one described above.

8. CERTHIDEA LUTEOLA, new species.

Specific characters.—Most like *C. olivacea*, Gould, of James and Jervis islands, but much brighter olivaceous above and (except in very abraded plumage) distinctly buff-yellowish beneath.

Habitat.—Chatham Island, Galapagos.

Adult male (type No. 56, coll. Dr. G. Baur, Chatham Island, June 17, 1891).—Above uniform bright olive or buffy-olive; wings and tail dusky, feathers broadly edged with the color of the back, the tips of the middle and greater wing-coverts (rather broadly) pale olive-buff, producing two indistinct bands across the wing. Superciliary streak extending from nostrils to above posterior angle of eye, eyelids, and entire under parts light buff-yellowish, deepest on throat, elsewhere tinged with olive, especially on sides and flanks; under wing-coverts and under tail-coverts, pale yellowish buff. Bill wholly deep black; "iris brown"; legs and feet dark brown. Wing, 2.13; tail, 1.52; exposed culmen, 0.40; tarsus, 0.82; middle toe, 0.45.

There are seven specimens of this very distinct form in Dr. Baur's collection, and six in the National Museum collection. None of the latter are in perfect plumage, however, and I have accordingly been obliged to select one of Dr. Baur's specimens as the type.

Two of Dr. Baur's specimens (both adult males, obtained June 17 and 18, while "in full song") and one of the National Museum specimens (obtained March 30, and in greatly worn plumage) have the bill entirely

deep black. All the rest have the under mandible pale brownish, the upper, deep brown or dusky. Among the latter are apparently adult birds of both sexes, obtained April 5, and June 16–18; but they may be young birds which have just assumed the adult plumage.

GEOSPIZA ASSIMILIS (Gould?).

Indefatigable Island (7 specimens); Albemarle (1?);* Cowly Bay, East Albemarle (1?);* Jervis (5).

Without a specimen of true *G. assimilis*, from Bindloe Island, for comparison, I am not sure as to the correctness of this identification. Whether *G. assimilis* or not, however, it certainly can not be referred either to *G. scandens* or *G. abingdoni*, being much larger-billed than the former and smaller-billed than the latter; in fact, it is about intermediate between the two, without, however, grading into either, so far as is indicated by a series of thirty-two specimens.†

It may be remarked that the color of the bill is the same in the three forms, when specimens of corresponding sex, age, and season are compared. Thus, although the adult male of *C. scandens* is described as having the bill varied with yellow, all of the six adult males in Dr. Baur's collection from James Island (the type locality) have the bill wholly black, as do also two males in striped plumage and an adult female. The plumage appears to be quite the same in the three forms.

Should this form prove to be different from *G. assimilis*, I propose for it the name *G. intermedia* (type No. 115916, U. S. N. M., Charles Island, April 8; C. H. Townsend).

9. GEOSPIZA BARRINGTONI, new species.

Specific characters.—Similar to *G. abingdoni*, Salvin, but bill much stouter, with tip less compressed and less acute. Wing, 2.70–2.80; tail, 1.58–1.62; culmen, 0.79–0.80; tarsus, 0.90; middle toe, 0.70.

Habitat.—Barrington Island. (Type, No. 596, in Dr. Baur's collection, obtained July 9, 1891.)

Dr. Baur's collection contains three specimens of this form, two adult males and a specimen in the streaked plumage.

10. GEOSPIZA PROPINQUA, new species.

Specific characters.—Very similar to *G. conirostris*, Ridgway,‡ of Hood Island, but bill still narrower, with the under mandible no broader than the upper; wing slightly shorter.

Measurements of type (No. 597, coll. Dr. G. Baur, Sept. 2, 1891).—Wing,

* The specimens from Albemarle and Cowly Bay, East Albemarle, being young birds, are very doubtfully placed here.

† The National Museum collection contains the following specimens of this form: Charles Island (10 specimens); Indefatigable (6); Chatham (1?)—the last doubtfully referred here.

‡ Proc. U. S. Nat. Mus. XII, No. 767, p. 106, Feb. 5, 1890 (Hood Island, Galapagos).

3.10; tail, 1.90; culmen, 0.85; width of lower mandible at angle, 0.23; of upper at notch, 0.23; tarsus, 0.95; middle toe, 0.68.*

Habitat.—Tower Island, Galapagos.

11. GEOSPIZA BAURI, new species.

Specific characters.—Similar to *G. media*, Ridgway.,† of Hood Island, but slightly larger, with bill much higher at base. Wing, 3.20; tail, 2; culmen, 0.80; depth of bill at base, 0.68; tarsus, 0.93.

Habitat.—James Island, Galapagos. (Type, No. 562, ♂ ad., coll. Dr. G. Baur, James Island, August 7, 1891.)

One adult male, an immature male, and an immature female are in Dr. Baur's collection.

This form approaches *G. strenua* in the size and form of the beak, but the gap between them is very considerable. The bill is also proportionally much more compressed than in *G. strenua*.

12. GEOSPIZA ALBEMARLEI, new species.

Specific characters.—Intermediate between *G. media*, of Hood Island, and *G. dubia*, Gould, of Chatham.

Habitat.—Albemarle Island, Galapagos.

Measurements of type.—(No. 115977, U.S.N.M., immature ♂, Tagus Cove, Albemarle Island, April 10, C. H. Townsend). Length (skin), 5; wing, 2.80; tail, 1.85; culmen, 0.70; gonys, 0.35; width of lower mandible at base, 0.41; depth of bill at base, 0.52; tarsus, 0.85; middle toe, 0.60.

The plumage of the type specimen is about half-way between that of the young male and the perfectly adult bird, the head and neck being nearly uniform dull blackish, the feathers of the dorsal region black, broadly margined with olive, the under parts (except throat) dull buffy whitish (marked with buffy olive laterally); the entire breast and fore part of sides heavily spotted (longitudinally) with blackish.

An adult female (No. 115978, U.S.N.M., same locality, etc.), is exactly like the immature male in coloration; its measurement being as follows: Length (skin), 5; wing, 2.82; tail, 1.70; culmen, 0.75; gonys, 0.40; width of under mandible at base, 0.42; depth of bill at base, 0.55; tarsus, 0.90; middle toe, 0.65.

Another female (No. 115975, U.S.N.M., same locality, etc.), evidently not a very young bird, since its bill, like that of the two above-mentioned specimens, is very hard and chiefly black in color, has the top of the head grayish olive, broadly streaked with dusky, the cheeks, chin, throat, etc., very pale grayish buffy, obsoletely streaked with darker,

* The extreme measurements of a series of 5 adult males are as follows: Wing, 2.95–3.15; tail, 1.85–1.95; culmen, 0.82–0.90; width of under mandible at angle, 0.23–0.26; of upper at notch, 0.22–0.26; tarsus, 0.90–0.95; middle toe, 0.68–0.75.

† Proc. U. S. Nat. Mus., XII. No. 767, p. 107, Feb. 4, 1890.

and the breast rather indistinctly marked with dusky. Length (skin), 4.70; wing, 2.78; tail, 1.70; culmen, 0.70; gonys, 0.38; width of under mandible at base, 0.40: depth of bill at base, 0.52; tarsus, 0.90; middle toe, 0.62.

13. GEOSPIZA FRATERCULA, new species.

Specific characters.—Similar to *G. fortis*, Gould, of Charles Island, but smaller, the bill narrower and with culmen more convex. Adult males: Wing, 2.50–2.65; tail, 1.60–1.65; culmen, 0.65–0.67; depth of bill at base, 0.43–0.49; tarsus, 0.78–0.80.

Habitat.—Abingdon Island, Galapagos. (Type, No. 116110, U.S.N.M., Abingdon Island, April 16; C. H. Townsend.

Five adult males in the National Museum collection from Abingdon Island agree in the above character, by which they may readily be distinguished from *G. fortis*, of Charles Island. There are four young birds in the collection, but no adult females. Mr. Salvin says that "the females from Abingdon Island are darker than those from the other two islands" (Indefatigable and Bindloe).

14. GEOSPIZA DEBILIROSTRIS, new species.

Specific characters.—Similar to *G. fortis*, Gould, in size, but feet larger and stouter, and bill conspicuously smaller. Wing, 2.93; tail, 1.75; culmen, 0.60; depth of bill at base, 0.35; tarsus, 0.95; middle toe, 0.67.

Habitat.—James Island, Galapagos. (Type, No. 116003, U.S.N.M., ♂ ad., James Island, April 11; C. H. Townsend.)

Of this very distinct species I have seen but one specimen. The plumage is "solid" black, varied by a slight admixture of buffy whitish on the middle of the abdomen, and broad terminal margins of the same to the longer under tail-coverts, becoming tinged with bright rusty anteriorly. The bill is wholly deep black, the legs and feet brownish black.

The bill is shaped exactly as in *G. fuliginosa*. but is slightly larger.

15. GEOSPIZA ACUTIROSTRIS, new species.

Specific characters.—Similar to *G. parvula*, Gould, but bill longer, with straighter outlines, and extremely acute at tip.

Measurements of type.—Wing, 2.45; tail, 1.58; culmen, 0.55; depth of bill at base, 0.30; tarsus, 0.75; middle toe, 0.53.

Habitat.—Tower Island, Galapagos. (Type in Dr. Baur's collection.)

The form of the bill in this species is conspicuously unlike that of any other, being almost exactly that of *Carduelis*.

There are 7 specimens in Dr. Baur's collection, 4 of which are in the black plumage.

16. CAMARHYNCHUS ROSTRATUS, new species.

Specific characters.—Similar to *C. habeli*, Sclater and Salvin, of Abingdon Island, but larger, with the bill much deeper and broader with much more strongly arched culmen.

Habitat.—James Island, Galapagos; Indefatigable Island (?).

Adult male (type, No. 116006, U.S.N.M., James Island, April 11; C. H. Townsend).—Head, neck, and chest dull black, passing into dusky sooty brown on forehead; rest of upper parts dull grayish olive, much lighter on rump and upper tail-coverts; lower parts from breast backward dull white, tinged with buff posteriorly, especially on under tail-coverts; breast, particularly on sides, indistinctly but rather broadly streaked with dusky. Bill black, brownish on gonys; tarsi deep horn-brown; toes dusky. Length (skin), 5.30; wing, 3; tail, 1.80; culmen, 0.62, very strongly arched; depth of bill at base, 0.48, from base of culmen to angle of gonys, 0.50; width of under mandible at base, 0.37; tarsus, 1; middle toe, 0.70.

Immature male (No. 116039, U.S.N.M., Indefatigable Island, April 12; C. H. Townsend).—Above light grayish olive, the top of the head rather grayer, broadly but rather indistinctly streaked with dusky, the feathers of the back still more broadly but much less distinctly darker medially. Supraloral region, malar and suborbital regions and entire under parts dull grayish white, faintly tinged with yellowish buff, especially on chest and breast; the former and sides of the latter broadly but very indistinctly streaked with grayish dusky. Bill dusky horn-color, light brown on edge of upper and terminal two-thirds of under mandible; tarsi and toes brownish black. Length (skin), 5.30; wing, 2.90; tail, 180; culmen, 0.60, very strongly arched; depth of bill at base, 0.45; from base of culmen to angle of gonys, 0.47; tarsus, 0.90; middle toe, 0.62.

This bird, although from James Island, can not be the same as *C. psittaculus*, for, although I have not been able to compare it with an adult male of the latter, the dimensions are much too great and the form of the bill far too different.

17. CAMARHYNCHUS PRODUCTUS, new species.

Specific characters.—Similar to *C. pauper*, Ridgway, of Charles Island, but bill longer, with culmen more arched, and gonys less convex, the sides of the under mandible with several oblique ridges; wing and tail decidedly and tarsus slightly longer. Wing, 2.90; tail, 1.80; culmen, 0.70, exposed portion, 0.55; depth of bill at nostril, 0.32; tarsus, 0.90; middle toe, 0.60.

Habitat.—Albemarle Island, Galapagos. (Type, No. 404, ♂, coll. Dr. G. Baur, Albemarle Island, July 31, 1891.)

The form of the bill in this species is so exactly intermediate between that of the thin-billed *Camarhynchi* and the *Cactorni* of the *C. pallida* group that it may almost be as well placed in one "genus" as the other!

18. CAMARHYNCHUS SALVINI, new species.

Specific characters.—Most like *C. prosthemelas*, Sclater and Salvin, but adult male without black on head, neck, or chest, the latter, together

with sides and flanks, being broadly streaked with dusky. Immature birds, of both sexes (and adult females?), much more yellowish beneath (usually strongly buff-yellow), always distinctly streaked with dusky on chest, sides, and flanks.

Habitat.—Chatham Island, Galapagos. (Type, No. 125977, U.S.N.M., Chatham Island, March 30, 1891; C. H. Townsend.)

In addition to the 11 specimens in the National Museum collection, collected by Mr. C. H. Townsend, naturalist of the U. S. Fish Commission steamer *Albatross*, Dr. Baur's collection contains 7 examples of this very distinct species from the same island.

19. CAMARHYNCHUS AFFINIS, new species.

Specific characters.—Similar to *C. psittaculus*, Gould, from James and Jervis islands, but smaller and with the chest rather broadly and distinctly streaked with dusky.

Habitat.—Albemarle Island, Galapagos.

Adult? (type, No. 598, Dr. Baur's collection, Cowly Bay, on mountains, August 10, 1891).—Above light brownish olive, lighter on rump, rather grayer on top of head, where indistinctly streaked with dusky; superciliary stripe (passing to a little behind eye), malar region, and under parts light grayish buff, tinged with brownish on sides (almost Isabella-color on flanks), and nearly white on abdomen, the chest and sides of breast broadly and rather distinctly streaked with dusky. Bill light brown, paler and yellower on under mandible; legs and feet dusky horn-color. Length (skin), 4.15; wing, 2.75; tail, 1.70; culmen, 0.55; depth of bill at base, 0.40; width of under mandible at base, 0.35; tarsus, 0.90; middle toe, 0.55.

Two other specimens in Dr. Baur's collection measure as follows: Wing, 2.50–2.60; tail, 1.50–1.70; culmen, 0.50–0.55; depth of bill at base, 0.40; width of under mandible at base, 0.30; tarsus, 0.82–0.85.

20. PYROCEPHALUS CAROLENSIS, new species.

Specific characters.—Similar to *P. nanus*, Gould (from James Island), but female deep buff beneath, instead of clear, light Naples yellow, and upper parts browner.

Habitat.—Charles Island, Galapagos.

Adult male (No. 115926, U.S.N.M., Charles Island, April 8; C. H. Townsend).—Lores, ear-coverts, occiput, hind neck, and remaining upper parts uniform blackish brown,* becoming lighter, more grayish, brown on lower rump, upper tail-coverts, and tips of wing-coverts, the edges of the secondaries still paler, and tips of secondaries, inner primaries and tail-feathers pale grayish brown, passing on terminal margins into brownish white; outermost tail-feathers pale grayish brown, its outer web slightly paler and faintly tinged with pink. Entire pileum glossy dark vermilion; lower parts scarlet-vermilion,

*A little darker and warmer than "clove-brown."

paler posteriorly (flesh-color on under tail-coverts), deepest on breast, and on throat somewhat broken by exposure of white bases of the feathers; under wing-coverts and axillars flesh-color, the former mixed with dusky. Bill black, under mandible somewhat brownish basally; legs and feet black. Length (skin), 4.85; wing, 2.50; tail, 2; exposed culmen, 0.42; tarsus, 0.72; middle toe, 0.40.

Immature male (No. 115927, U.S.N.M., Charles Island, April 8; C. H. Townsend).—Above dusky brown* (very much paler than in adult), paler and grayer on rump and upper tail-coverts, many of the feathers of lower back and scapulars showing very indistinct and narrow paler tips; wings and tail as in the adult, but the former rather paler; fore-head and fore part of crown whitish, tinged with flesh-pink (especially near nostrils), each feather marked with a rather broad mesial streak of dusky brown, the hinder part of crown nearly uniform dusky, but the feathers light vermilion or flesh-red beneath the surface. Lores and orbits dusky, the ear-coverts paler and faintly tinged with flesh-pink; chin, throat, and malar region white, very faintly tinged with flesh-pink, especially on chin; rest of under parts flesh-color, deepest on flanks, paler on chest and breast, where narrowly streaked with dusky. Bill and feet as in adult. Length (skin), 5; wing, 2.60; tail, 2.03; exposed culmen, 0.45; tarsus, 0.71.

Adult female (No. 115928, U.S.N.M., same date, etc.).—Above grayish olive, becoming gradually paler and more grayish (nearly "hair brown") on rump and upper tail-coverts; crown somewhat streaked with paler; forehead, superciliary region, and malar region, whitish, tinged with buffy yellowish. Chin and throat buffy white; rest of under parts, deep buff-yellow, the chest marked with a few very indistinct dusky streaks. Bill and feet as in the male. Length (skin), 4.80; wing, 2.50; tail, 2.05; exposed culmen, 0.48; tarsus, 0.70; middle toe, 0.40.

An adult male in more worn plumage (No. 125988, U.S.N.M., Charles Island, April 1; C. H. Townsend) is, through fading, a more pronounced brown color above than the example described above. The two other adult females show no trace of streaks on the chest.

21. PYROCEPHALUS INTERCEDENS, new species.

Specific characters.—Similar to *P. nanus*, Gould, (from James Island), but female much brighter yellow beneath, browner above, and top of head more tinged with yellow.

Habitat.—Indefatigable Island, Galapagos.

Adult male (No. 418, coll. Dr. G. Baur, Indefatigable Island, August 5, 1891).—Similar above to males from Charles Island (*P. carolensis*) but still darker (brownish black rather than blackish brown); beneath similar on chin, throat, and chest, but from breast back the color of a

* Much "warmer" than sepia.

decided orange-red or flame-scarlet hue. Wing, 2.58; tail, 2.18; exposed culmen, 0.47; tarsus, 0.75; middle toe, 0.38.

Adult female (No. 439, coll. Dr. G. Baur, Indefatigable Island, August 6).—Color above quite the same as that of females from Charles Island, but top of head with a decided yellowish tinge; superciliary stripe, extending from nostrils to posterior angle of eye (broadest anteriorly), light buff-yellowish; malar region, chin, and throat very pale maize-yellow; rest of under parts light chrome, or deep Naples-yellow—very different from the buff-yellow of Charles Island specimens. Wing, 2.38; tail, 2; exposed culmen, 0.40; tarsus, 0.70.

Immature male (No. 463, same collection, Indefatigable Island, August 7).—Very similar to the adult female, but rather darker above; chin and throat white, faintly tinged with maize-yellow; rest of lower parts rather deeper and decidedly "warmer" yellow than in the adult female (a very pale tint of "deep chrome"), rather paler on the chest, where marked with very narrow shaft-streaks of dusky. Wing, 2.52; tail, 2.05; exposed culmen, 0.45; tarsus, 0.71; middle toe, 0.40.

An immature male (No. 77764, U.S.N.M., Indefatigable Island, August 25–Oct. 16, Dr. A. Habel) is similar to that described above, but has the yellow of the chest equally deep with that of more posterior under parts (the whitish throat being thereby more abruptly defined) and the fine dusky streaks nearly obsolete. Wing, 2.40; tail, 2.02; exposed culmen, 0.45; tarsus, 0.70; middle toe, 0.39.

Young (No. 116053, U.S.N.M., Indefatigable Island, April 12; C. H. Townsend).—Above dark grayish brown, the feathers of the back, the scapulars, and the lesser wing-coverts narrowly and rather indistinctly margined with paler; those of the rump and upper tail-coverts much more broadly margined with brownish buff, which constitutes the prevailing color; top of head broadly streaked with dusky on a whitish and pale buffy ground, the forehead chiefly pale buffy; middle and greater wing-coverts broadly tipped with pale brownish buffy, producing two wing-bands; tail feathers also broadly tipped with pale dull buffy; remiges rather broadly margined at tips with whitish. Supraloral region, malar region, chin, and throat whitish, tinged with dull yellowish; rest of under parts light Naples-yellow, the chest, sides, and flanks longitudinally flecked with grayish brown.

22. PYROCEPHALUS ABINGDONI, new species.

Specific characters.—Similar to *P. carolensis*, Ridgway, in color of back, etc., but red of under parts very different—flame scarlet or orange-chrome instead of vermilion. (Female and young unknown.)

Adult male (type, No. 116134, U.S.N.M., Abingdon Island, Galapagos, April 16, 1888; C. H. Townsend).—Pileum intense scarlet or scarlet-vermilion, paler, more orange-red, on forehead; entire under parts orange-red ("orange-chrome"), the under tail-coverts paler, inclining to salmon-color; ear-coverts, hind neck, back, etc., clove-

brown (very nearly same color as in *P. carolensis*). Length (skin), 4.95; wing, 2.55 (?)*; tail, 2.10 (?); exposed culmen, 0.48; width of bill at base, 0.23; tarsus, 0.75.

Another adult male (No. 116135, U.S.N.M., same date, etc.) is similar, but has the pileum deeper red (intense vermilion) and the fore neck and chest slightly tinged with vermilion. Exposed culmen, 0.45; width of bill at base, 0.25; tarsus, 0.73. (Wing and tail too imperfect for measurement.)

An adult male from Bindloe Island, in Dr. Baur's collection, is similar in color of back, etc., to these Abingdon examples, but the under parts are very different, the anterior half being pure scarlet and the posterior half, very abruptly pale saturn-red. The bill is also extremely narrow. Whether the differences are of an individual character or characteristic of the locality can not be determined from only one specimen.

Measurement.—Length (skin), 4.40; wing, 2.48; tail, 2.12; exposed culmen, 0.40; width of bill at base, 0.20; tarsus, 0.67.

PYROCEPHALUS DUBIUS, Gould.

Pyrocephalus dubius, GOULD, Zool. Voy. Beagle, Birds, 1841, 46.
Pyrocephalus nanus, AUCTORUM, part, not of GOULD.
Pyrocephalus minimus, RIDGWAY, Proc. U. S. Nat. Mus., XII, No. 767, p. 113, in text, Feb. 5, 1890 (Chatham Island, Galapagos).

This very distinct form was separated by me, provisionally, from *P. nanus*, as *P. minimus*, in the paper above cited, without being described in detail. The fourteen specimens subsequently received bring out very strongly its distinctive characters, and show it to be very different indeed from *P. nanus* and its nearer allies, from which, in any plumage, specimens may be distinguished at a glance. The different plumages represented in the series before me may be described as follows:

Specific characters.—Decidedly smaller than *P. nanus* Gould and other Galapagoan forms; adult male with lower parts conspicuously paler and duller red than pileum; back, etc., lighter and browner than in other forms; adult female with conspicuous superciliary stripe and under parts deep ochraceous-buff, the throat paler, but scarcely approaching white.

Habitat.—Chatham Island, Galapagos.

Adult male (No. 72, coll. Dr. G. Baur, Chatham Island, June 18, 1891).—Entire pileum glossy dark vermilion, exactly as in other forms; lower parts pale scarlet, deepest on breast, much paler on throat, and still more so on chin, which inclines to reddish white. Lores, ear-coverts, and upper parts in general deep brown (intermediate between "seal" and "clove"), decidedly lighter and browner than in other forms; tips of wing coverts, edges of secondaries, and whole of outer tail-feathers paler, more grayish, brown. Length (skin), 4.35; wing, 2.23; tail, 1.90; exposed culmen 0.38; tarsus, 0.65; middle toe, 0.35.

* The molt is nearly completed, but the longest primaries and rectrices may not be fully grown.

Nearly adult male (No. "B," coll. Dr. G. Baur, Chatham Island, June 16).—Much like the fully adult male, as described above, but red of pileum paler and mixed with many partly brown feathers, that of under parts very much paler (deep salmon-color, very much paler on chin and throat), and upper parts decidedly lighter warm grayish brown. Wing, 2.28; tail, 2.05; exposed culmen, 0.36; tarsus, 0.65; middle toe, 0.35.

Adult female (No. 63, coll. Dr. G. Baur, Chatham Island, June 17).—Forehead and broad superciliary stripe, extending from nostrils to occiput, ochraceous-buff; rest of pileum nearly same color, but broadly streaked with deep hair-brown, these streaks so broad on hind part of crown as to nearly conceal the buffy edgings. Ear-coverts, hind neck, back, scapulars, and lesser wing-coverts uniform hair-brown, the rump, upper tail-coverts, and broad tips of greater and middle wing-coverts paler and tinged with buffy; secondaries edged for terminal half with pale buffy grayish, and broadly margined at tips with buffy grayish white. Malar region, chin, and throat pale buff, deeper laterally; rest of under parts deep buff, becoming rather clearer and brighter posteriorly, and everywhere devoid of the least trace of streaks. Length (skin), 4.25; wing, 2.21; tail, 1.88; exposed culmen, 0.38; tarsus, 0.65; middle toe, 0.32.

Immature male (No. 123, coll. Dr. G. Baur, Chatham Island, June 25).—Much like the adult female, as described above, but top of head nearly uniform grayish brown, like back, though showing indistinctly defined broad streaks of darker and lighter, with a few concealed bright yellow spots on center of crown; anterior part of forehead and superciliary stripe, however, deep buffy, as in the female; buff of under parts deeper and yellower. Length (skin), 4.25; wing, 2.30; tail, 1.92; exposed culmen, 0.39; tarsus, 0.63; middle toe, 0.38.

The adult male described is the brightest colored one in a series of eight, the remainder being more or less paler scarlet beneath. This conspicuous difference of intensity between the red of the pileum (which is exactly as in other forms) and that of the lower parts is, next to the small size, the most striking character of the present species.

Two other females in Dr. Baur's collection differ from that described in having an appreciable (though in case of one very faint) yellow tinge to the posterior under parts.

Another immature male, also in Dr. Baur's collection, is quite decidedly yellowish on the posterior lower parts, the under tail-coverts and malar region being nearly maize-yellow.

There can be little doubt, I think, that Gould's *Pyrocephalus dubius* was based on a female or immature male of this form, but the question can be determined positively only by examination of the type, now in the British Museum. The original description certainly fits the female very well, and the measurements of the type, recently made for me by

Dr. Sclater, indicate a very small bird—smaller, in fact, than the smallest in the series of sixteen specimens from Chatham Island.

Dr. Sclater's measurements are materially different from those given by Gould, as the following will show. For convenience of comparison, the fractions of the latter are changed from duodecimals to decimals:

Measurements of Pyrocephalus dubius.

Authority.	Wing.	Tail.	Exposed culmen.	Tarsus.	Specimen.
Gould	2.26	1.77	....	0.60	Type of *P. dubius*, Gould.
Sclater	2.15	1.60	0.40	0.60	Type of *P. dubius*, Gould.
Smallest female from Chatham Island.	2.20	1.80	0.45	0.62	No. 125989, U. S. N. M.

DESCRIPTIONS OF SOME NEW BIRDS FROM ALDABRA, ASSUMPTION, AND GLORIOSA ISLANDS, COLLECTED BY DR. W. L. ABBOTT.

By Robert Ridgway,
Curator of the Department of Birds.

In the last volume of these Proceedings* descriptions were published of seven new species of birds† collected by Dr. W. L. Abbott on the above-mentioned islands, an eighth new form‡ having been later characterized in The Auk.§ Other species in Dr. Abbott's collection were identified with forms already described, though some of them were doubtfully determined, no specimens of the birds they were supposed to represent being available for comparison. Duplicates of some of these were sent to Prof. Alfred Newton, who has made a special study of the birds of the Madagascar subregion. Prof. Newton has kindly informed me that they are in reality new forms, and has most generously sent me specimens of the species to which I had referred them in order that I might see wherein they were different. I am thus under the necessity of describing six more new birds which have been brought to light by Dr. Abbott's careful explorations.

A more elaborate paper on the avian fauna of these interesting islands, together with the Seychelles, Amirantes, etc., based primarily on Dr. Abbott's collection, but including also the results of the work of previous collectors, is nearly completed and will in due time be published.

1. ZOSTEROPS ALDABRENSIS, new species.

Specific characters.—Similar to *Z. palpebrosa* (Temminck), but supraloral region (sides of forehead) distinctly orange-yellowish, under parts with yellow of chest extending farther backward and tinging the median line of the belly; chest and sides less tinged with gray (some specimens having instead a faint brownish wash), and under tail-coverts

* Proc. U. S. Nat. Mus., XVI, pp. 597–600, No. 953, published August 16, 1893.

†*Ixocincla madagascariensis rostrata*, *Buchanga aldabrana*, *Foudia aldabrana*, *Rougetius aldabranus*, *Ibis abbotti*, *Sula abbotti*, and *Turtur saturatus*.

‡*Rougetius abbotti*.

§The Auk, January, 1894, p. 74.

very different in color from chest (varying from maize- to chrome-yellow, the throat being canary-yellow).

Habitat.—Aldabra Island. (Type, No. 128702, U.S.N.M., ♂ ad., Aldabra Island, October 3, 1892; Dr. W. L. Abbott.)

Measurements of type.—Length (before skinning), 4.25; wing, 2.12; tail, 1.62; exposed culmen, 0.35; tarsus, 0.70; middle toe, 0.37. "Upper mandible, black; lower, leaden; feet, leaden; irides, light brown." (ABBOTT, MSS.)

2. ZOSTEROPS MADAGASCARIENSIS GLORIOSÆ, new subspecies

Characters of subspecies.—Very similar to true *Z. madagascariensis* (Gmelin), but larger (?), upper parts less vivid olive-green, and under tail-coverts brighter yellow.

Habitat.—Gloriosa Island. (Type, No. 128706, U.S.N.M., ♀ ad., Gloriosa Island, January 25, 1893; Dr. W. L. Abbott.)

Measurements of type.—Length (before skinning), 4.50; wing, 2.17; tail, 1.42; exposed culmen, 0.40; tarsus, 0.65; middle toe, 0.38. "Bill, black; base of lower mandible, leaden; irides, pale brown; feet, leaden." (ABBOTT, MSS.)

Having only one specimen of true *Z. madagascariensis* for comparison, I am not quite satisfied of the propriety of separating the Gloriosa bird, which I do more in deference to Prof. Newton's views than to my own convictions.

3. CINNYRIS ALDABRENSIS, new species.

Specific characters.—Similar to *C. souimanga* (Gmelin), but pectoral band much broader and bright maroon-bay instead of chestnut; sooty breast-patch much more extensive, reaching, medially, to middle of belly; sides and flanks light yellowish gray, and lower belly very pale sulphur-yellow (whole belly canary-yellow in *C. souimanga*). Female much grayer above and darker below, anteriorly, than that of *C. souimanga*.

Habitat.—Aldabra Island. (Type, No. 128673, U.S.N.M., ♂ ad., Aldabra Island, October 1, 1892; Dr. W. L. Abbott.)

Measurements of type.—Length (before skinning), 4.36; wing, 2.10; tail, 1.50; exposed culmen, 0.70; tarsus, 0.65; middle toe, 0.40. "Bill and feet black." (ABBOTT, MSS.)

4. CINNYRIS ABBOTTI, new species.

Specific characters.—Similar to *C. aldabrensis*, but with under parts posterior to maroon-bay pectoral band almost entirely sooty black, with flanks more or less extensively light yellowish gray; upper tail-coverts glossy violet-black, tipped with metallic greenish blue. Female similar to that of *C. aldabrensis*.

Habitat.—Assumption Island. (Type, No. 128680, U.S.N.M., ♂ ad., Assumption Island, September 18, 1892; Dr. W. L. Abbott.)

Measurements of type.—Length (skin), 3.90; wing, 2.22; tail, 1.62; exposed culmen, 0.70; tarsus, 0.67; middle toe, 0.40.

5. CENTROPUS INSULARIS, new species.

Specific characters.—Quite identical in nuptial plumage with *C. toulou* (Müller); in other plumages, however, very much paler, the posterior under parts barred with pale brownish buff and dusky, in nearly equal quantity (uniform greenish dusky in corresponding plumage of *C. toulou.*)

Habitat.—Aldabra and Assumption islands. (Type, No. 128715, U.S.N.M., ♀ ad., Aldabra, October, 1892. "Upper mandible, horny brown; lower pale horny; irides, red; feet, bluish black." (ABBOTT, Mss.)

Measurements vary so, both in this form and in *C. toulou*, that I have been unable to derive any satisfactory character from them. The present bird appears, however, to have almost invariably smaller feet than *C. toulou*, as the following measurements show:

Measurements of Centropus toulou.

Museum and number.	Sex and age.	Locality.	Date.	Wing.	Tail.	Culmen.	Depth of bill.	Tarsus.	Outer toe.
A. N.	♂ ad.	Madagascar	1873	6.55	9.60	1.32	.63	1.65	1.20
U. S., 118599.	♀ ad.	do		5.85	9.50	1.28	.65	1.65	1.15
A. N.	♀ ad.	do		6.45	8.70	1.30	.60	1.67	1.17
A. N.		do	1879	5.85	9.20	1.17	.52	1.50	.98

Measurements of Centropus insularis.

Museum and number.	Sex and age.	Locality.	Date.	Wing.	Tail.	Culmen.	Depth of bill.	Tarsus.	Outer toe.
U. S., 128717.	♂ ad.	Aldabra	Nov. 18	5.95	9.35	1.10	.50	1.32	1.
U. S., 128714.	♀ ad.	do	Sept. 25	6.70	10.25	1.30	.60	1.50	1.13
U. S., 128716.	♂ ad.	do	Oct. 4	6.	9.75	1.12	.55	1.43	1.05
U. S., 128715.	♀ ad.	do	Oct. 3	6.60	10.80	1.20	.60	1.50	1.13
U. S., 128712.	♂ ad.	Assumption	Sept. 18	5.85	8.70	1.10	.55	1.45	1.03

6. CAPRIMULGUS ALDABRENSIS, new species.

Specific characters.—Similar to *C. madagascariensis*, Grandidier, but averaging larger; scapulars marked with grayish white instead of buff; foreneck without collar of buffy spots, and white of tail more extensive (that on lateral feathers extending 1.70 inches from tip in adult male).

Habitat.—Aldabra Island. (Type No. 128668, U. S. N. M., ♂ ad., Aldabra Island, September 29, 1892, Dr. W. L. Abbott.)

Measurements of type.—Length (before skinning), 9.25; wing, 6.25; tail, 4.35; middle toe, 0.65.

A REVISION OF THE FISHES OF THE SUBFAMILY SEBASTINÆ OF THE PACIFIC COAST OF AMERICA.*

By Carl H. Eigenmann and Charles H. Beeson.

The primary object of the present paper is to present analytical keys, synonymy, and bibliography of the viviparous genera of Pacific Sebastinæ. For the sake of convenience the oviparous genera of Sebastinæ have also been added. The Scorpænidæ fall naturally into two groups or subfamilies: the tropical Scorpæninæ with twenty-four vertebræ, of which Scorpæna is found in all tropical seas; and the much more numerous Sebastinæ inhabiting both of the temperate and both of the colder zones, and which invariably have an increased number of vertebræ. While this subfamily has a wide distribution, the number of species found in the north temperate regions of the Pacific Ocean is much larger than that of all other regions combined.

The Scorpæninæ in the region covered by this paper are all shore fishes in the most restricted sense of the word. The Sebastinæ, on the other hand, are rarely found in less than 100 feet of water, except while young, and much more frequently are found in a depth of 600 feet. Some of the species live in more than twice this depth. The horizontal as well as vertical distribution of any given species is usually quite limited; but a single species, *Sebastosomus ruber*, seems to range from San Diego to Alaska, and only one species, *Sebastolobus macrochir*, a deep sea form, is found off the coasts of both Japan and the United States. The widest range is that of *Sebastomus capensis*, found in Chilean and Cape seas. The following notes by Prof. Eigenmann on the habitat of the San Diego species describe their vertical range:†

The members of this family * * * seem to live at definite depths, and on bottom peculiar to each species or group of species. This does not imply that their distribution is narrowly limited, but that a given species may or may not be found at any point within the limits of its habitat, as the peculiarities of the bottom at a

*The classification adopted by the authors of this paper is based on their own peculiar interpretation of the importance of certain structural characters. The arrangement and nomenclature proposed will not be, at present at least, followed in the National Museum.—Editor.

†Proc. Cal. Acad. Sci., 2nd ser., III, 1890, 11 p.

given depth are fitted for it or not. To this cause is to be attributed, in part, the fact that so many northern forms have but lately been added to the fauna of San Diego, and that a given species may be caught for several days in succession, and then not appear again for some time. As the different rock-cod boats have found new conditions, even within a few hundred yards of their usual fishing grounds, they invariably have brought novelties. Thus on one day, *S. proriger* [=*macdonaldi*], *rufus*, *eos* and *melanostomus* * * * were all brought by one boat which had accidentally found new conditions. [All were new to science.] * * * *S. ruber* and *levis* are frequently associated, while *rubrivinctus*, *elongatus*, *chlorostictus*, *constellatus*, *rosaceus*, *vexillaris*, *chrysomelas* and *serriceps* form another group.

The Sebastinæ are seemingly as abundant on the coast of Japan as they are on the coast of the United States. Few species extend further south than the boundary of the United States and they are entirely absent from Mexico and other tropical coasts, but reappear on the coast of Chile in *Sebastomus oculatus*, which is synonymous with *S. capensis* of the Cape seas.

We have examined most of the American species, but none of the Japanese forms. We are fully aware of the hazardous nature of attempting a generic subdivision of a large number of species when a good percentage of the whole number is not available for study, and especially when the absent members practically all belong to a particular region; but an examination of the skeletons of a large number of species warrants us, in the absence of other evidence, to considerably increase the number of genera heretofore admitted. The condition of the parietals has been taken as the primary character for generic division and the constant presence or absence of certain cranial spines, associated with a number of minor characters, have been drawn upon to furnish definitions for the genera heretofore united under the names *Sebastodes*, *Sebastomus*, *Sebastosomus*, and *Sebastichthys*.

The cranial spines used in generic definitions are located as follows: (1) The preocular is the continuation of the upper posterior angle of the prefrontal into a spine. It is usually present. (2) The supraocular, (3) the postocular, and (4) the tympanic are always near the outer border of the frontal. The last of this series of spines always overarches a mucous pore and is present and homologous throughout the group. The postocular, on the other hand, is absent in several genera. (5) The coronals are also on the frontals, but nearer their middle and directly in front of the parietal ridges. They are developed in but few species. There seems to have been a confusion of this name in the Scorpæninæ and the spine called coronal in *Scorpæna* does not seem homologous with the spine called coronal in *Auctospina*, which has just been described. (6) The parietals (occipital of Jordan and Gilbert), as their name implies, are on the parietal bones and form the spine at the end of the ridge running near the middle of these bones. (7) The nuchals are much less constant and their taxonomic value consequently much less than that of the other spines. They are formed by the transverse division of the parietal ridges.

This revision is based:

(1) On a collection made by Prof. Eigenmann during a three years' stay in California. Many of the species were here examined in large numbers as they were brought to the markets. Collections were made at San Diego, Cortes Bank, Monterey, and San Francisco. A nearly complete series of these were presented to the National Museum.

(2) On many of the specimens collected by Jordan and Gilbert, which now belong to the National Museum and to the Indiana University.

(3) A series of skulls and skeletons belonging to Mrs. Eigenmann's collection formed the basis for the classification into genera.

We are indebted to Dr. G. Brown Goode for the use of species belonging to the National Museum and not otherwise accessible to us. To Messrs. Gilbert and Test we are indebted for examinations of otherwise inaccessible specimens, and to Messrs. Gill and Jordan for suggestions and criticisms.

HISTORICAL NOTE ON THE VIVIPAROUS GENERA.

The species of *Sebastodes*, *Sebastichthys*, etc., were originally included in the long known genus *Sebastes*. Dr. Gill first distinguished between genera in the following historical sequence:

1. *Sebastodes*, GILL, Proc. Phila. Acad. Sci., 1861, p. 165 (*Sebastes paucispinis*, AYRES).
2. *Sebastichthys*, GILL, *l. c.* 1862, pp. 278, 329 (*S. nigrocinctus*, AYRES, type; *S. nebulosus*, AYRES, *S. auriculatus*, GIRARD, *S. ocellatus*, CUVIER, *S. helvomaculatus*, AYRES, *S. melanops*, GIRARD, and *S. rosaceus*, AYRES.
3. *Sebastosomus*, GILL, *l. c.* 1864, pp. 59, 147 (*S. melanops*, GIRARD), to include also *Sebastosomus pinniger*, GILL.
4. *Sebastomus*, GILL, *l. c.* 1864, pp. 59, 147 (*S. rosaceus*, GIRARD).

In the last paper quoted, Dr. Gill says:

> In conclusion, the genus *Sebastichthys* includes at least three genera. The *Sebastichthys nigrocinctus* is somewhat related to *Scorpæna*, and is distinguished by elevated, serrated coronal [parietal] crests. Other California species represented by the *Sebastes melanops*, seen by me, differ so much that they may be separated and combined for the present under a genus *Sebastosomus*, of which the *Sebastes melanops* of Ayres may be taken as the type. Still others, distinguished by the texture of the bones of the skull, armed orbital ridges, prefrontals, etc., and represented by *Sebastes rosaceus*, Girard, may be named *Sebastomus*.

In 1880 Jordan and Gilbert* retained *Sebastodes* as a distinct genus, but united all the other known species under the name *Sebastichthys*, retaining *Sebastosomus* as a subgenus.

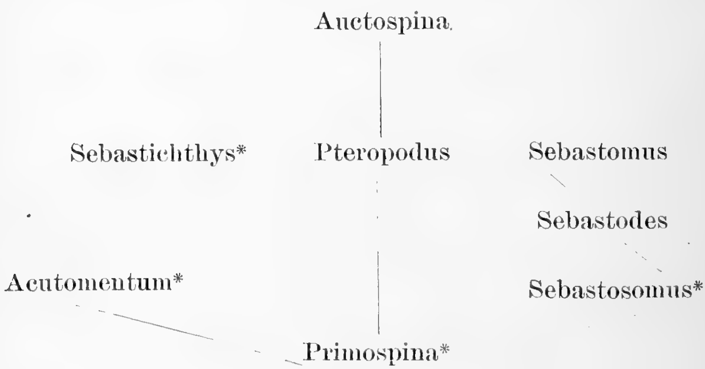
These genera, *Sebastodes*, *Sebastichthys*, *Sebastosomus*, *Sebastomus*, were again united by Jordan and Gilbert† in 1882, under the generic name *Sebastodes*, with the remark, "the species differ greatly in form of armature, but the genera based on these differences intergrade too closely to be worthy of retention."

*Proc. U. S. Nat. Mus. III, 1880, p. 287 (1881).
†Bull. U. S. Nat. Mus., XVI, 1883.

In 1885 Dr. Jordan* again separated the genus *Sebastodes* from the other species which remained united under the name *Sebastichthys*.

More recently Eigenmann,† after describing *S. goodei*, remarked "the genus *Sebastodes* will either have to be merged with *Sebastichthys* or the latter divided into other genera." The material for this further division was not at hand at the time and *Sebastodes* was adopted as defined by Jordan and Gilbert. The present examination of skulls has shown that the intergradation of the armature of the head noticed by them is of secondary importance only, and largely due to their arrangement of the species to emphasize this intergradation in armature, and that, as soon as the large number of species are separated on the more essential relation of the parietals to the supraoccipital, the intergradations largely vanish, and the groups originally defined by Gill come to the foreground as valid genera, with the addition of several other genera. An outline of the classification, here more fully treated, was published by us in the American Naturalist for July, 1893.

The interrelation of the various genera is complex. Our conception of it may be illustrated by the following diagram, the genera with united parietals being marked with an asterisk.



The last general account of these forms to appear was that of Jordan and Gilbert in the Synopsis of the Fishes of North America. At that time only about 30 species were known. Since then about 20 species have been described. This large increase in the number of known species, and the observed incongruity of grouping were the chief agents leading to the present revision, which we hope to be a step in the right direction. The synonymy is all simple, and the species have been for the most part well described. We have therefore omitted any further discussion of the former and confined the descriptions to the keys.

*Cat. Fish. N. Am., 1885; Rept. U. S. Comr. of Fish and Fisheries, 1884 (1885).
†Proc. Cal. Acad. Sci., 2nd ser., III., p. 12, 1890.

ANALYSIS OF THE PACIFIC COAST GENERA OF SEBASTINÆ.

a. Vertebrae 27 or more .... (SEBASTINÆ).

b. Dorsal spines 14–16; the lower pectoral rays thickened, unbranched, and produced; ventrals directly under pectorals. Suborbital stay strong, spiniferous .... SEBASTOLOBUS, I.

bb. Dorsal spines 13; vertebræ 27.

c. Palatines with teeth. Lower pectoral rays unbranched, their tips projecting.

d. Parietals meeting above the supraoccipital,* except sometimes in *Primospina.*

e. Jaws equal; head narrow above; high and prominent cranial keels ending in spines. Preocular, supraocular, tympanic, and parietal present. Gill-rakers usually short, spatulate or clavate, their broadened tips spiniferous. Scales usually very strongly ctenoid; accessory scales numerous; suborbital stay directed obliquely downward and backward; second anal spine much heavier than and at least as long as third. Body short and deep, back arched, mouth very large but rather narrow, head heavy. Inter- and sub-opercle without spine. Branchiostegals and lower jaw naked. Three or four large pores along each ramus of the lower jaw. Species usually with cross bands .... SEBASTICHTHYS, II.

ee. Lower jaw much projecting; head broad, skull usually convex; cranial ridges when present usually low. Gill-rakers very long and slender; scales usually smooth, few if any accessory scales. Branchiostegals and lower jaw scaled. Pores of lower jaw concealed except in some species of *Acutomentum.*

f. Preocular spines well developed. Peritoneum black.

g. Postocular spine present. Supraocular, tympanic and occipital spines well developed. Second anal spine stronger and usually longer than the third. Symphyseal knob strong, projecting forward. Dorsal low. Lower pectoral rays normal, not thickened. No spines on inter- and sub-opercles. (Mandible and maxillary scaled) .... ACUTOMENTUM, III.

gg. Postocular spines not developed. Supraocular and tympanic sometimes present, always concealed by the skin. Occipitals ending in spines or not. Interorbital wide, convex. Lower pectoral rays thickened, their tips projecting beyond the membrane. Bones of the skull striate and pitted. Mouth small, narrow. Spines on inter- and sub-opercle sometimes present. Peritoneum black .... PRIMOSPINA, IV.

ff. Preocular without spine; skull smooth, without spines. Lower pectoral rays normal. No spines on inter- or sub-opercle. Peritoneum usually white .... SEBASTOSOMUS, V.

dd. Parietals separated by the supra occipital.†

h. Cranium with parietal ridges only. Lower jaw much projecting, entering the profile; a prominent symphyseal knob directed forward. Head broad, convex. Interorbital convex, nearly smooth. Lower pectoral rays normal; no spines on inter- and sub-opercles. Exposed branchiostegals, maxillary and mandibles densely scaled. Pores of lower jaw concealed by the scales .... SEBASTODES, VI.

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* See *Sebastomus æreus* and *elongatus.*

† Except in *æreus* and sometimes in *elongatus.*

hh. Cranium with many ridges all ending in spines. Branchiostegals (except in *A. aurora*, *S. proriger*, and *S. rufus*) and usually the lower jaw naked. Pores of lower jaw, except in *Auctospina*, very large, conspicuous, slit-like.

i. Postocular and tympanic spines both present. Lower pectoral rays thickened (except in *Sebastomus rufus*). Interopercle and subopercle usually with spines.

j. Coronal spines, nuchal spines; a spine below, another in front of eye........Genus. (?) (single species MATZUBARÆ), VII.

jj. Coronal spines not developed..............SEBASTOMUS, VIII.

ii. Postocular spine not developed; interopercle and subopercle each with a spine at their approximated corners.

k. Coronal spines not developed; lower pectoral rays usually thickened; interorbital usually with a groove in its middle. The large pores (4) along each ramus of the lower jaw open. Maxillary, mandible, and branchiostegals usually naked or with minute embedded scales............PTEROPODUS, IX.

kk. Coronal spines developed; interorbital with a median ridge; gill-rakers long; lower pectoral rays normal, not thickened and fleshy. Pores of lower jaw (in *auriculatus*) entirely closed by a thin membrane................AUCTOSPINA, X.

cc. Palatines without teeth. Preocular, supraocular, postocular, tympanic, parietal, nuchal, and coronal spines developed. Suborbital stay with a sharp spiniferous ridge.......SEBASTOPSIS, XI.

I. Genus SEBASTOLOBUS, Gill.

Sebastolobus, GILL, Rep. Smithsonian Institution, 1880 (*macrochir*).
TYPE.—*Sebastes macrochir*, GÜNTHER.

This genus is known from two species found in deep water. It is characterized by the position of its ventrals and by the peculiar shape of its pectorals. The upper rays are the longer and the lower five are thickened and prolonged beyond the membranes much as in many species of *Pteropodus*, *Sebastichthys*, and other genera.

ANALYSIS OF THE SPECIES OF SEBASTOLOBUS.

a. Second anal spine one-seventh of the length; highest dorsal spine, 2½ in the head; eye 1½ times as long as snout; a large black spot on the posterior half of the spinous dorsal, and another between the anal spines. D. XV, 6-9; A. III, 5. Lat. l, ca. 45 (Günther)..............................MACROCHIR, 1.

aa. Second anal spine one-fifth of the length; highest dorsal spine three in head; eye twice as long as snout; a dark blotch on membranes between first and third dorsal spines, and one from sixth to eleventh spine (Bean)......ALASCANUS, 2.

1. SEBASTOLOBUS MACROCHIR (Günther).

Sebastes macrochir, GÜNTHER, Ann. Mag. Nat. Hist. (4), XX, 434 (Japan); *id.*, *Challenger* shore fishes, p. 65, pl. xxvii, 1880 (Inland Sea of Japan, off Inosima, 345 fathoms). This species, first described from Japan, has been found to be quite abundant off the coast of the United States.

2. SEBASTOLOBUS ALASCANUS, Bean.

Sebastolobus alascanus, BEAN, Proc. U. S. Nat. Mus., XIII, 1890, p. 44 (1891). (Off Trinity Island, West Long. 154°, North Lat. 56°, at a depth of 159 fathoms.) It is probable that this is only the young of *macrochir*.

II. Genus SEBASTICHTHYS, Gill.

Sebastichthys, GILL, Proc. Acad. Nat. Sci. Phila. 1862, p. 278 (*nigrocinctus*).

Sebastichthys, JORDAN and GILBERT, Proc. U. S. Nat. Mus. III., 1880, p. 287 (sp.) (1881).

TYPE.—*Sebastes nigrocinctus*, AYRES.

When originally defining it Dr. Gill included in this genus the types which he afterwards* separated under other generic names. As here understood it comprises three species which are well separated from all other related genera by the prominent characters set forth in the key. The parietals in all three species cover all but a small posterior part of the supraoccipital. A fourth species which I have not seen (*diploproa*) seems to form an aberrant member of the genus.

ANALYSIS OF THE SPECIES OF SEBASTICHTHYS.

a. Gill-rakers short spatulate or clavate, their broadened tips spiniferous. Lower pectoral rays thickened and fleshy. Sides with cross bands.

b. Cranial ridges very rough, spinous; frontals with high crests between the eyes which sometimes end in coronal spines. Orange red, with 5 jet black vertical bars. A. III, 7; D. XIII, 15 .... NIGROCINCTUS, 1.

bb. Cranial ridges smooth; frontals without crests.

c. Scales of head ctenoid; cranial ridges very high, their spines isolated, high and heavy. Nuchal spines distinct from parietal spines. Dark olive, with about 7 oblique black cross bands. A. III, 5; D. XIII, 13.... SERRICEPS, 2.

cc. Scales of head cycloid; cranial ridges very low and long, the spines slender, acute. No nuchal spines. Pink or rose red with brilliant crimson cross bands .... RUBRIVINCTUS, 3.

aa. Gill-rakers long, slender, the longest half length of eye. Lower pectoral rays not enlarged.

d. Premaxillaries produced on each side of median line, forming two forwardly-projecting dentigerous lobes in the deep emargination, between which fits the tip of the mandible. Preorbital one-third pupil, with two strong diverging spines. Eye larger, 3–3½ in head; interorbital, 1⅗ in orbit, slightly concave. Longest dorsal spine, 2½ in head. Second anal spine longer and stronger than third, 2½–3 in head. Scales large, minutely spinous, and readily deciduous, very small and cycloid on maxillary, mandible, and breast. Fin membranes thick and scaled. Uniform rose-red above, bright silvery below, sparsely black-punctate. Peritoneum jet black. Spinous dorsal with dusky margins, the fins otherwise unmarked. Depth, 2¾; head, 2½. D. XIII, 12 or 13; A. III, 7; tubes, 35 (Gilbert) .... DIPLOPROA, 4.

1. SEBASTICHTHYS NIGROCINCTUS (Ayres).

Sebastes nigrocinctus, AYRES, Proc. Cal. Acad. Sci., II, 1859, pp. 25, 217, fig. 64.

Sebastichthys nigrocinctus, GILL, Proc. Acad. Nat. Sci. Phila., 1862, pp. 278, 329.—JORDAN and GILBERT, Proc. U. S. Nat. Mus. III, 1880, p. 455 (1881) (Puget Sound, Monterey Bay).—JORDAN and JOUY, Proc. U. S. Nat. Mus. 1881, p. 7, IV (1882) (Monterey and Puget Sound).—JORDAN and GILBERT, *l. c.*, p. 59.—BEAN, *l. c.*, p. 264 (Puget Sound, Vancouver Island); Proc. U. S. Nat. Mus. VI, 1883, p. 360, (1884), (Near St. Mary Island, Alaska).—JORDAN, Cat. Fish. N. Am., 1885, p. 108 (California).

Sebastodes nigrocinctus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 677, 1883, (San Francisco to Vancouver Island).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Monterey, San Francisco. Puget Sound).

HABITAT.—Monterey to Alaska. Rare.

* Proc. Acad. Nat. Sci., Phila., 1863, p. 147.

The spines of the cranium in this species are as high as those in *serriceps*. To those of *serriceps* are added median frontal ridges. With age the spines, as well as the frontal ridges, become broken into a large number of tubercles or spines so that the individuals of the primary spines can hardly be separated from each other. The frontal ridges in this way sometimes give rise to a tubercle corresponding in position to the coronal spines of *Auctospina*. The mucous canal system is very highly developed in this species. The specimens examined are from San Francisco and Monterey.

2. SEBASTICHTHYS SERRICEPS, Jordan and Gilbert.

Sebastichthys serriceps, JORDAN and GILBERT, Proc. U. S. Nat. Mus. III, 1880, p. 38 (1881) (Santa Catalina; Santa Barbara); *op. cit.*, p. 455 (San Francisco, Monterey, Santa Barbara, San Pedro, San Diego).—JORDAN and JOUY, Proc. U. S. Nat. Mus. IV, 1881, p. 7, (1882).—JORDAN and GILBERT, *l. c.*, p. 59 (San Diego to San Francisco).—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (name).—EIGENMANN and EIGENMANN, Notes, San Diego Biol. Lab. I, p. 7, 1889 (San Diego).

Sebastodes serriceps, JORDAN and GILBERT, Syn. Fish. N. Am., p. 676, 1883 (San Francisco to Cerros Island).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus. XV., 1892, p. 168 (1893), San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, 355 (San Diego, Cortes Bank, San Pedro, Santa Barbara, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco.

This is one of the smaller species and is abundant in shallow water. On the Cortes Bank I have taken it in 15 fathoms.

3. SEBASTICHTHYS RUBRIVINCTUS, Jordan and Gilbert.

Sebastichthys rubrivinctus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 146 (1881), (Monterey); *op. cit.*, p. 291 (Santa Barbara, Monterey, San Francisco); *op. cit.*, p. 455—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882), (Monterey)—JORDAN and GILBERT, *l. c.*, p. 57—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 7, and II, p. 1, 1889 (San Diego).

Sebastodes rubrivinctus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 670, 1883 (Santa Barbara to Monterey)—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (name)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., 1892, p. 167 (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, Santa Barbara, Monterey).

HABITAT.—San Diego to Monterey.

This species is only occasionally taken. The specimens examined are from San Francisco, San Diego, and Cortes Bank.

4. SEBASTICHTHYS DIPLOPROA, Gilbert.

Sebastichthys diploproa, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 79 (1891), (coast of California, south of Point Conception).

Sebastodes diploproa, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Santa Barbara).

HABITAT.—Coast of California, south of Point Conception.

This species has not been seen by us, and we place it in this genus with some hesitation. Dr. Gilbert informs us that the parietals are united.

III. Genus ACUTOMENTUM, Eigenmann and Beeson.

Acutomentum, EIGENMANN and BEESON, Amer. Nat., July, 1893 (*ovalis*).
TYPE.—*Sebastodes ovalis*, AYRES.

This genus is composed of about four species. While these agree with each other in the technical characters distinguishing the genus, they show considerable variation in other characters. *A. melanostomus* approaches *Sebastichthys* in shape of head and body. *A. ovalis*, on the other hand, is a compressed fish with narrow head. In this last species the sharp chin from which the genus derives its name is most conspicuous.

ANALYSIS OF THE SPECIES OF ACUTOMENTUM.

a. Nuchal spines; skull wide, concave between the large postocular spines. Lining of mouth and of gill-cavity black. Short and deep; head heavy; mouth large; lower jaw projecting, maxillary reaching to below posterior border of pupil. Eye equal to snout, $3\frac{5}{6}$ in head. Interorbital $4\frac{3}{4}$ in head, preorbital 3 in orbit, with an anterior simple and a posterior many pointed spine. Maxillary, mandible, preorbital, and snout scaly. Scales of opercle rather large; scales of the sides very large; accessory scales few. Gill rakers $3\frac{1}{2}$ in orbit. Dorsal spines very low, about 4 in head; anal spines graduated. Scarlet, shading into madder brown or blackish red above the lateral line. Fins vermilion, the first dorsal, with its membranes, narrowly black edged. All other fins more or less black on distal half, the caudal most so. Head vermilion, tinged with black. Head $3\frac{1}{4}$ in the total length; D. XIII, 13; A. III, 7; lat. l. 43 .... MELANOSTOMUM, 1.

aa. Nuchal spines or none; gill cavity dusky. Elongate. General appearance of *Sebastomus proriger*. Head pointed, lower jaw projecting, maxillary reaching to below posterior margin of eye, 2 in head. Interorbital slightly convex, without ridges. Cranial ridges low, obscure, but all terminating in sharp spines; pre- supra- and postocular, tympanic and occipital spines present. Eye small; orbit $1\frac{2}{5}$ in snout, $4\frac{3}{4}$ in head, $1\frac{1}{6}$ in interorbital. Preorbital $\frac{3}{5}$ of an orbital diameter, with 3 retrorse spines below, the posterior the smallest; a retrorse spine just below the orbit. Opercular spines simple and strong. Mandible, maxillaries, suborbitals, and entire snout scaled. Scales of the head small and strongly ctenoid, those of the body larger. Outlines of spinous dorsal regularly arched, the 4th and 5th spines highest, 3 in the head; highest articulate ray $3\frac{2}{5}$ in the head. Anal spines graduated, the second being stronger but considerably shorter than the third, which is $5\frac{1}{3}$ in the head; highest ray 3 in the head. Pectorals extending somewhat beyond the ventrals. Peritoneum black. Top of head and back chiefly black, lateral line vermilion; a blackish band just below the lateral line becoming much wider forward and extending on the sides below the fifth dorsal spine. A large opercular spot, a broad band downward and backward from eye, a narrow one across cheeks below the eye, lips and tip of lower jaw chiefly black; the rest of the head and sides chiefly vermilion. Anal and ventrals vermilion; pectorals and caudal blackish; dorsals nearly black. Axils dusky. Head 3 in the total length; depth $3\frac{3}{4}$; D. XIII, $13\frac{1}{2}$; A. III, $7\frac{1}{2}$ .... MACDONALDI, 2.

aaa. No nuchal spine; skull convex between the postocular spines. Lining of mouth and of gill-cavity pale. Cranial ridges low. Dorsals low.

Lower spines of preopercle short and flat, the second not reaching base of third. Highest dorsal spine $2\frac{1}{2}$ in head. Oval, deep, compressed. Lower jaw with an acute, antrorse symphyseal knob. Preorbital narrow, with a sharp retrorse spine. Gill rakers long, $1\frac{1}{2}$ in orbit. Eye little longer than snout. Second anal spine longer and stronger than third, $2\frac{1}{3}$ in head. Maxillary and mandible scaly. Peritoneum black. Head olivaceus, strongly tinged with creamy red, especially below; membrane of both dorsals covered with many small, round, black spots; similar spots usually on the body. Head 3; depth $2\frac{3}{4}$; D. XIII, 14; A. III, 8; tubes 70 .... OVALIS, 3.

bb. Lower spines of preopercle large, the second reaching beyond base of third. Second anal spine enlarged, much stronger and longer than third, $2\frac{1}{8}$ in head; highest dorsal spine $2\frac{3}{4}$ in head. Caudal peduncle $\frac{1}{4}$ the depth; maxillary extending to middle of pupil, $2\frac{1}{3}$ in head; interorbital space flat, $1\frac{1}{3}$ in orbit. Eye $3\frac{1}{4}$ in head. Preorbital very narrow, lobate, but without spines. Scales small, rough; those above lateral line much smaller than others and irregularly disposed; those on breast, snout, maxillary, and mandible smooth. Gill rakers 2 in orbit. Dusky above, with faint traces of darker blotches along back. A dark blotch on opercle, one on subopercle, and one on upper half of axil. Top of head, including membrane of premaxillary, dusky. Spinous dorsal with a dark marginal band; other fins, except pectorals, margined with black. Peritoneum black. Head $3\frac{2}{3}$; depth $3\frac{1}{5}$; D. XIII, 15; A. III, 8; tubes 50 [Gilbert] .... ALUTUM, 4.

1. ACUTOMENTUM MELANOSTOMUM, Eigenmann and Eigenmann.

Sebastodes melanostomus, EIGENMANN and EIGENMANN, Proc. Cal., Acad. Sci. 2d Ser., III, p. 17, 1890 (San Diego); *id.* Proc. U. S. Nat. Mus., XV, 1892, p. 164, (1893), (San Diego); *id.* Ann. N. Y. Acad. Sci. 1892, p. 355.

Sebastichthys introniger, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 81 (1891) (coast of California south of Point Conception).

Sebastodes introniger, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355.

HABITAT.—Coast of California south of Point Conception.

2. ACUTOMENTUM MACDONALDI, Eigenmann and Beeson.

Sebastodes proriger, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 2d Ser. III, p. 15 (San Diego), not *S. proriger*, JORDAN and GILBERT.

Acutomentum macdonaldi, EIGENMANN and BEESON, Amer. Nat., July, 1893 (San Diego).

HABITAT.—Off San Diego in 100 fathoms.

This species is known from a single specimen in the National Museum. In general appearance it resembles *S. proriger*, with which it was for a time confounded. The original description is reproduced in the key.

3. ACUTOMENTUM OVALIS (Ayres).

Sebastodes ovalis, AYRES, Proc. Cal. Acad. Sci., 1862, p. 212, fig. 65—JORDAN and GILBERT, Syn. Fish. N. Am., p. 660 (coast of California)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 163 (1893), (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, Santa Barbara, Monterey).

Sebastichthys ovalis, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 143 (Monterey Bay); p. 455 (Monterey Bay, Santa Barbara)—JORDAN and JOUY,

Proc. U. S Nat. Mus., IV, 1881, p. 8 (1882), (Monterey)—JORDAN and GILBERT, *l. c.*, p. 56; JORDAN, Cat. Fish. N. Am., p. 107, 1885—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 7, and II, p. 1, 1889 (San Diego).

HABITAT.—San Diego to Monterey.

4. ACUTOMENTUM ALUTUM, Gilbert.

Sebastichthys alutum, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 76 (1891) (coast of California south of Point Conception).

Sebastodes alutum, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 354.

HABITAT.—Coast of Southern California.

This species seems to resemble *S. rufus*. If the parietals are separate it must be transferred to *Sebastomus*. The species is known from the types only.

IV. Genus PRIMOSPINA, Eigenmann and Beeson.

Primospina, EIGENMANN and BEESON, Amer. Nat., July, 1893 (*mystinus*).

TYPE.—*Sebastichthys mystinus*, JORDAN and GILBERT.

This genus is composed of only two variable species. The skull is thick, and there is greater variation in the presence or absence of spines in different individuals of the same species, than in any other genus. Preocular spines are always developed, but supraocular and tympanic spine are present in some individuals and not in others. The parietal ridges end in spines in one species but not in the other. From this genus as a center have been developed in one direction the genera *Sebastosomus*, *Sebastodes*, and *Sebastomus*. In another direction *Pteropodus*, *Auctospina*, and still in another *Acutomentum* and *Sebastichthys* have become differentiated.

ANALYSIS OF THE SPECIES OF PRIMOSPINA.

a. Parietal ridges not terminating in spines. Oblong, depth $2\frac{3}{4}$; slaty black, paler below the lateral line; sides more or less mottled .... MYSTINUS, 1.

aa. Parietal ridges ending in spines. Oblong elongate, depth $3\frac{1}{4}$; dull olive green; sides with obscure round, rusty spots .... ENTOMELAS, 2.

1. PRIMOSPINA MYSTINUS (Jordan and Gilbert).

Sebastes variabilis, AYRES, Proc. Cal. Acad. Sci., I, p. 7, 1854 (San Francisco). [not of Pallas.]

Sebastodes melanops, AYRES, Proc. Cal. Acad. Sci., II, p. 216 (in part).

Sebastichthys melanops, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 287.—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 5, and II, p. 1, 1889 (Cortes Bank, San Diego).

Sebastichthys mystinus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (1881), (Puget Sound, San Francisco, Monterey, Santa Barbara, San Pedro, San Diego).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882), (Monterey, San Francisco).—JORDAN and GILBERT, *l. c.*, p. 70.—BEAN, *l. c.*, p. 265 (Puget Sound).—JORDAN, Cat. Fish. N. Am., p. 107, 1885 (California).

Sebastodes mystinus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 659, 1883 (Puget Sound to San Diego).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus.,

xv, 1892, p. 163 (1893), (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, San Pedro, Santa Barbara, Monterey, San Francisco, Puget Sound).

HABITAT.—San Diego to Puget Sound.

This species varies more than any other in its armature and in the degree of convergence of the parietals, facts which lend weight to the supposition that it is the central species about which the others are grouped. The specimens examined are from San Francisco and show the following variations:

Individual variations in Primospina mystinus.

Catalogue No. of specimen.	Parietals.	Inter- and sub-opercular spines.		Postocular spines.	Tympanic spines.
1085	Separate				Knob.
1360	Joined	Slight	Present		Do.
1171	do		Slight		Do.
1193	do	Slight	do		1 spine.
1087	do	Present	Present	Present	Knobs.
1092	Separate			1 present	Do.
1137	Joined		Present	1 knob	Knob.
1190	do	Present	do	do	2 spines.
1115	Separate	do	do	2 short spines.	2 knobs.

2. PRIMOSPINA ENTOMELAS (Jordan and Gilbert).

Sebastichthys entomelas, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 142 (1881), (Monterey Bay); *op. cit.*, p. 455 (San Francisco, Monterey Bay).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8, (1882), (Monterey).—JORDAN and GILBERT, *l. c.*, p. 56.—JORDAN, Cat. Fish. N. Am., p. 107, 1885.

Sebastodes entomelas, JORDAN and GILBERT, Syn. Fish. N. Am., p. 659, 1883 (Monterey).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 35 (Port Harford, Monterey, San Francisco).

HABITAT.—Port Harford to San Francisco, Cal.

This species is only provisionally placed here. We have not examined it, but Mr. F. C. Test informs us that the parietals are united, and that the parietal ridges end in minute spines. In the last point this species agrees with the genus *Acutomentum*, but the absence of postocular and the occasional absence of supraocular and tympanic spines unite this variable species with the variable *Primospina*.

V. Genus SEBASTOSOMUS (Gill).

Sebastosomus, GILL, Proc. Acad. Nat. Sci. Phila., 1864, p. 147 (*melanops*).—EIGENMANN and BEESON, Amer. Nat., July, 1893 (redefined).

TYPE.—*Sebastes melanops*, Girard.

This genus differs from all others in the fact that no cranial spines are developed.

ANALYSIS OF THE SPECIES OF SEBASTOSOMUS.

a. Peritoneum white.

b. Snout acuminate, the lower jaw strongly projecting, entering the profile. Anal truncate or subtruncate.

c. Eye large, 1 in snout, 1 in interorbital, 4 in head. Tips of nasal spines free. Parietal ridges well developed. Highest dorsal spine $2\frac{2}{5}$–$2\frac{3}{5}$ in head. Pala-

tine band of teeth of nearly uniform width. Olivaceous, yellowish on sides, lighter below. Sides with rusty spots usually near the tips of scales. Base of spinous dorsal sometimes spotted. Second dorsal, caudal, and anal bright orange, margined with black. An orange streak down and back from eye, a broader one back from eye, a narrow one on maxillary. Pectorals and ventrals orange or brassy, blackish tipped. Head 3; depth about 3; D. XIII, $14\frac{1}{2}$; A. III, $8\frac{1}{2}$ .... FLAVIDUS, 1.

cc. Eye smaller, $1\frac{1}{3}$ in snout, $1\frac{1}{4}$–$1\frac{1}{5}$ in interorbital, $4\frac{1}{2}$ in head. Tips of nasal spines concealed. Highest dorsal spine $2\frac{4}{5}$–3 in the head. Band of palatine teeth usually much narrower at the middle than at the ends. Gray, darker above, with a series of large light spots on the back. Fins colored like the body, the second dorsal, the caudal, and anal yellowish. Head 3; depth $3\frac{1}{3}$–$3\frac{1}{2}$. D. XIII, $15\frac{1}{2}$; A. III, $9\frac{1}{2}$ .... SERRANOIDES, 2.

bb. Snout blunt, lower jaw scarcely projecting. Anal rounded. Eye slightly more than 4 in the head. Highest dorsal spine $2\frac{1}{2}$–3 in head. Pectorals rounded, not reaching tips of ventrals. Dark gray, with small darker spots. Black spots on base of spinous dorsal. Head 3; depth 3–$3\frac{1}{5}$; D. XIII, $13\frac{1}{2}$; A. III, $7\frac{1}{2}$–$8\frac{1}{2}$ .... MELANOPS, 3.

aa. Peritoneum black. Mouth smaller than in *melanops*, the maxillary reaching to below posterior margin of pupil; lower jaw somewhat projecting but without prominent knob at the symphysis; preorbital narrow without spine; lower jaw fully scaled; highest dorsal spine a little less than half head. Gill rakers numerous, very long and slender, nearly as long as the eye. Head $3\frac{1}{3}$; depth $3\frac{1}{3}$; D. XIII, $15\frac{1}{2}$; A. III, $8\frac{1}{2}$. Blackish green, the sides rather pale, much mixed with darker; fins dusky, the upper mottled; dark shades from eye backward. (Jordan and Gilbert) .... CILIATUS, 4.

1. SEBASTOSOMUS FLAVIDUS (Ayres).

Sebastodes flavidus, AYERS, Proc. Cal. Acad. Sci., p. 209, fig. 64, 1862.—LOCKINGTON, Proc. Cal. Acad. Sci., VII, p. 81, 1876 (San Francisco).—JORDAN and GILBERT, Syn. Fish. N. Am., p. 657, 1882 (coast of California).—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 5, 1889, in part (San Diego); *id.*, Proc. Cal. Acad. Sci., 2d ser., III, p. 36, 1890 (San Diego); *id.*, Proc. U. S. Nat. Mus., 1892, p. 163 (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 354 (San Diego, Cortes Bank, Santa Barbara, Monterey, and San Francisco).

Sebastichthys flavidus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (San Francisco, Monterey, San Pedro, San Diego). —JORDON and JOUY, Proc. U. S. Nat. Mus., 1881, p. 8 (Monterey, and San Francisco).—JORDAN and GILBERT, Proc. U. S. Nat. Mus., 1881, p. 55 (San Diego to Cape Mendocino, Monterey).—JORDAN, Cat. Fish. N. Am., p. 107 (California).

HABITAT.—San Diego to Puget Sound.

2. SEBASTOSOMUS SERRANOIDES (Eigenmann and Eigenmann).

Sebastodes flavidus, EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 5, 1889 (San Diego), in part [not *flavidus* of Ayres]; *id.*, Proc. U. S. Nat. Mus., 1892, p. 163 (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 354 (San Diego).

Sebastodes serranoides, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 2d ser., III, p. 35, 1890 (San Diego); *id.*, Proc. U. S. Nat. Mus., 1892, p. 163 (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 354 (San Diego, Cortes Bank, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco, in rather shallow water.

The specimens examined are from San Diego and San Francisco.

3. SEBASTOSOMUS MELANOPS (Girard).

Sebastes melanops, GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, VIII, p. 135.—GIRARD, U. S. Pac. R. R. Surv., 1858, X, p. 81 (Cape Flattery to Astoria).—GÜNTHER, II, p. 98, 1860 (copied).—SUCKLEY, U. S. Pac. R. R. Surv., 1860, XII, p. 354 (Puget Sound).—AYRES, Proc. Cal. Acad. Sci., fig. 66, 1862.—LOCKINGTON, Proc. Cal. Acad. Sci., 1876, p. 81 (San Francisco).

Sebastichthys melanops, GIRARD, Proc. Acad. Nat. Sci., Phila., 1862, p. 278.—JORDAN & JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Neah Bay, Washington, Monterey, San Francisco).—JORDAN and GILBERT, Proc. U. S. Nat. Mus., IV, 1881, p. 56 (1882) (Monterey northward).—BEAN, Proc. U. S. Nat. Mus., IV, 1881, p. 252 (1882) (Monterey, San Francisco, Puget Sound, Sitka); and p. 269 (Alaskan peninsula to or beyond San Francisco).—JORDAN, Cat. Fish. N. Am., p. 107, 1885 (California).

Sebastodes melanops, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., VI, 1892, p. 354 (Monterey, Alaska).

Sebastosomus simulans, GILL, Proc. Acad. Nat. Sci., Phila., 1864, p. 147 (Cape Flattery).

HABITAT.—Monterey to Alaska.

We have been unable to recognize *S. simulans* from the following note constituting its sole description "* * * two species are apparently confounded by Girard and the name *Sebastes melanops*, one with 'a small spine upon the suprascapular bone, two others upon the edge of the opercle,' and another from Cape Flattery with the lower opercular spine as well as the supraorbital ridges obsolete, and the forehead between the eyes perfectly arched."

4. SEBASTOSOMUS CILIATUS (Tiles).

Epinephelus ciliatus, TILES, Mém. Acad. Sci., St. Petersburg, IV, p. 474, 1810.

Sebastichthys ciliatus, JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Kodiak).—BEAN, Proc. U. S. Nat. Mus., IV, 1881, p. 252 (1882) (Aleutians; Kodiak); and pp. 267 and 271 (Alaska); *op. cit.*, 1883, p. 359 (Mary Island; Tolstoi Bay, Alaska; Nakat Harbor, Pt. Chester, Alaska).—JORDAN, Cat. Fish. N. Am., p. 107, 1885 (Alaska).

Sebastodes ciliatus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 658, 1883 (Alaska).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Alaska).

Perca variabilis, PALLAS, Zoogr. Rosso. Asiat., III, p. 241, 1811.

Sebastes variabilis, CUVIER and VAL., IV, p. 347, 1829.—GÜNTHER, Cat. Fish. Brit. Mus., II, p. 99, 1860.

HABITAT.—Alaska.

VI. Genus SEBASTODES, Gill.

Sebastodes, GILL, Proc. Acad. Nat. Sci., Phila., 1861, p. 165 (*paucispinis*); EIGENMANN and BEESON, Amer. Nat., July, 1893 (redefined).

TYPE.—*Sebastes paucispinis*, AYRES.

Dr. Gill rightly insisted that *Sebastes paucispinis*, Ayres is generically distinct from *S. nigrocinctus*, etc. Such a separation is, however, admissible only if the heterogenous species, usually lumped under the generic name *Sebastichthys*, are relegated to their respective genera. The genus approaches *Sebastomus* through *S. goodei*. The genus *Sebastomus*, on the other hand, closely approaches this genus through *S.*

elongatus. In the weak cranial armature it closely approaches *Sebastosomus flavidus*, etc.

ANALYSIS OF THE SPECIES OF SEBASTODES.

a. Preopercular spines radiating, the two lowest directed downward. Head heavy, broad, the lower jaw not greatly projecting. Posterior angle of mandible below middle of orbit. Clear vermilion, no black anywhere; fins vermilion, membranes of dorsal dusky. A. III, 8; tubes in lateral line 54.... GOODEI, 7.

aa. Preopercular spines all directed caudad, the two lower ones remote from the rest and much smaller. Head long, pointed, the lower jaw much projecting. Posterior angle of mandible behind the orbit orange red, darker above, many irregular dark blotches and dots; young olivaceous. A. III, 9; tubes in lateral line 65–80, scales 90–100 .... PAUCISPINIS, 2.

1. SEBASTODES GOODEI, Eigenmann and Eigenmann.

Sebastodes goodei, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 2d ser., III, p. 12, 1890 (San Diego), p. 36 (San Francisco); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 163 (1893) (San Diego); *id.*, Ann., N. Y. Acad. Sci., 1892, p. 354 (San Diego, Monterey, San Francisco).

Sebastichthys goodei, GILBERT, Proc. U. S. Nat. Mus., XII, 1890, p. 75 (1891) (Coast of California, south of Point Conception).

HABITAT.—San Diego to San Francisco. Locally abundant.

2. SEBASTODES PAUCISPINIS (Ayres).

Sebastes paucispinis, AYRES, Proc. Cal. Acad. Sci., I, p. 6, 1854 (San Francisco).—GIRARD, U. S. Pac. R. R. Surv., VI, p. 15, pl. xxii*a*, figs. 1–4, 1855 (San Francisco); *op. cit.*, X, p. 83, pl. xii*a*, figs. 1–4, 1858.—GÜNTHER, Cat. Fish. Brit. Mus., II, p. 98, 1860.

Sebastodes paucispinis, GILL, Proc. Acad. Nat. Sci., Phila., 1861, p. 165.—AYRES, Proc. Cal. Acad. Sci., 1862, p. 215.—GILL, Proc. Acad. Nat. Sci., Phila., 1862, p. 278 (California).—JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (1881) (San Francisco, Monterey, San Luis Obispo, Santa Barbara, San Pedro).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Santa Barbara, Monterey, San Francisco).—JORDAN and GILBERT, *l. c.*, p. 55 (from San Francisco to the Santa Barbara Islands).—BEAN, *l. c.*, p. 472 (Port McLaughlin, Brit. Columbia).—JORDAN and GILBERT, Syn. Fish. N. Am., p. 656, 1883 (Coast of California).—JORDAN, Cat. Fish. N. Am., p. 107, 1885.—EIGENMANN and EIGENMANN Note, San Diego Biol. Lab., I, p. 5, 1889 (Cortes Bank); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 163 (1893) (Cortes Bank, San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 354 (San Diego, Cortes Bank, San Pedro, Santa Barbara, Port Harford, Monterey, San Francisco).

HABITAT.—San Diego to British Columbia. Abundant.

VII. GENUS ALLIED TO SEBASTOMUS.

Perca variabilis, PALLAS, Zoogr. Rosso. Asiat., III, p. 241, 1811 (in part).

Sebastes matzubaræ, HILGENDORF, Sitzber. Gesellschaft Naturforschender Freunde Berlin 1880, p. 170.

Sebastodes matzubara, JORDAN, Proc. Acad. Nat. Sci., Phila., 1883, 291.

HABITAT.—Aleutian Islands.

This species is known to us from descriptions only. It seems to form the type of a genus related to *Sebastomus*, but we leave the

determination of its generic relationships to some one who has specimens.

VIII. GENUS SEBASTOMUS, Gill.

Sebastomus, GILL, Proc. Acad. Nat. Sci., Phila., 1864, p. 147 (*rosaceus*).

TYPE.—*Sebastes rosaceus, Girard.*

The species of this genus are all closely related. The armature of the skull varies but little. *S. ruber*, with broken cranial ridges, stands at one extreme, *S. levis* at the other. The bulk of the species have several pale spots on the sides which are similarly arranged in the different species.

ANALYSIS OF THE SPECIES OF SEBASTOMUS.

a. Cranial ridges entire.

b. Median portion of interorbital with a convex ridge. Cranial ridges low, bones of cranium striate or granular; symphyseal knob projecting nearly as in *Sebastosomus flavidus;* second anal spine little longer or stronger than third.

c. Gill-rakers very long, $1\frac{1}{2}$ in orbit; scales all ctenoid.

d. Supraocular, postocular, and tympanic spines tubercular or pyramidal, very broad and short, directed upward more than backward. Dorsal spines $2\frac{3}{4}$ in head. Symphyseal knob very sharp. Numerous accessory scales above lateral line and on tail. Anal spines graduated, slightly more than 3 in head. Outlines of spinous dorsal little arched. Compressed, elongate. Maxillary reaching to middle of eye. Interorbital slightly convex, as wide as orbit or little wider. Eye longer than snout $3\frac{1}{2}$–4 in head. Preorbital 4 in orbit, with 2 small, backward directed spines. Head entirely covered with moderate-sized scales, body with larger ones. Rufous, variously marked with brown. Lateral line rufous. Upper angle of opercle, a line from eye to upper half of pectoral, another parallel to it from upper angle of maxillary backward, and tips of jaws dark brown. Axil black. Margin of spinous dorsal and greater part of membranes of soft dorsal black. Caudal dusky. Membranes of remaining fins chiefly black. Head 3; depth $3\frac{1}{2}$; D. XIII, 14; A. III, 8. Tubes in lat. l. 56 .... RUFUS, 1.

dd. Supraocular, postocular and tympanic spines all slender, conical, their acute tips directed backward more than upward. Dorsal spines about $2\frac{1}{4}$ in head. Symphyseal knob blunt. Accessory scales few. Head broad, the interorbital 3 in the distance from tip of snout to base of occipital crest. Mandible, maxillary, and tip of snout scaly. Membranes of spinous dorsal not greatly incised.

e. Scales of mandible very rough; color chiefly brick red..... MINIATUS, 2.

ee. Scales of mandible smooth; color chiefly orange........... PINNIGER, 3.

cc. Gill-rakers short, not more than three times as high as wide. Scales of head cycloid, those of body weakly ctenoid; accessory scales numerous. Head narrow, the interorbital $4\frac{3}{5}$ in the distance from tip of snout to base of occipital crest. Mandible, maxillary, and tip of snout naked. Highest dorsal spine little less than half length of head, the mem-

brane of the first three spines meeting the succeeding spines at their basal fifth. Second anal spine thick. Pink. Four interrupted crossbars of black..... LEVIS, 4.

bb. Median portion of the interorbital deeply grooved; bones of cranium smooth polished; gill-rakers rather short; accessory scales numerous; second anal spine usually much stronger and longer than third. Upper parts (except in *gilli* and *rupestris*) with three to five pink blotches, one below end and one below origin of soft dorsal; one below middle of spinous dorsal just above the lateral line, frequently a smaller one above this near the base of the fin; usually one at the base of the fourth dorsal spine.*

f. Dorsal spines moderate, considerably less than half length of head.

g. Preorbital with three flat spines. Maxillary and mandible entirely scaled; second anal spine little longer than third, considerably shorter than the rays, $2\frac{1}{3}$ in the head. Pink overlaid with bronze; top of head, and back above lateral line bronze, the five spots pink. Sides below the lateral line finely vermiculated with bronze, which occupies more space than the ground color. Dorsal light bluish-pink clouded with bronze, the rays of all the other fins pink, the membrane bronze. D.XIII, 12–13; A.III, 6; tubes 37–40..ÆREUS, 5.

gg. Preorbital with two flat spines.

h. Upper half of body everywhere with conspicuous small round pink spots. Scales of the cheeks all minute, a few scales on upper part of maxillary and at angle on lower jaw. Interorbital narrow and very deeply concave .CONSTELLATUS, 6.

hh. Not marked with small round white or pink spots.

i. Gill-rakers two in orbit; both jaws with smooth, small scales, interorbital $\frac{2}{3}$ width of eye, supraocular ridge low. Many accessory scales. Pectoral not reaching vent. Light orange, everywhere overlaid with blackish, the latter color forming fine reticulations on lower part of sides. Light spots of sides large, ill defined. Head, $2\frac{2}{3}$; depth, $2\frac{4}{5}$; D.XIII, 12; A.III, 6 ....UMBROSUS, 7.

ii. Gill-rakers three or more in orbit.

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* *Sebastomus capensis* (LINNÆUS).

Sebastes capensis, LINNÆUS GMELIN, III, 1219.—CUVIER and VALENCIENNES, Hist. Nat. Poiss., IV, p. 341.—QUOY & GAIMARD, Astrol. Poiss., p. 690, pl. ii, fig. 3.—SMITH, S. Afr. Pisc., pl. 22, fig. 1.—GÜNTHER, Cat. Fish. Brit. Mus., II, 96, 1860 (Cape seas).—STEINDACHNER, Ichthyol. Beitr., X, 38, 1881 (Chilian and Cape seas).

Sebastes oculatus, CUVIER and VALENCIENNES, Hist. Nat. Poiss., IX, p. 466, 1833 (Valparaiso).—JENYNS, Zool. Beagle Fishes, p. 37 (Valparaiso).—GAY, Hist. Chil. Zool., II, p. 178 (Coast of Chili).—CUVIER, Regne Anim., Ill. Poiss., pl. 23, fig. 3.—GÜNTHER, Cat. Fish. Brit. Mus., II, 105, 1860 (copied).

Sebastes maculatus, SMITH, *l. c.*, fig. 2 (not of Cuvier and Valenciennes).

HABITAT.—Chilian and Cape seas.

Dr. Steindachner has, after direct comparison of specimens from Chili and from the Cape seas, identified the *S. oculatus* with *S. capensis*.

Head 3 in the total length; depth about $3\frac{1}{4}$; D. XIII, 14; A. III. 6. The interocular space equals rather more than half the diameter of the eye, is concave, with two longitudinal ridges. Second anal spine longest and strongest. Red. back brownish, with five round, red spots.

j. Without bronze spots.

k. Mandible naked; second anal spine moderate; pale blotches on sides surrounded by purple. Orange red, tinged or mottled with golden yellow. Fins rosy, mottled with orange; head with radiating stripes of orange and rosy; nape with alternating bars of yellowish and deep red. Second anal spine $2\frac{1}{3}$ in head; head, $2\frac{2}{3}$; depth, 3; D.XIII, 13; A.III, 6. . . . . ROSACEUS, 8.

kk. Mandible finely scaled near its base; second anal spine equal to maxillary, 2 in head. Bright rose red; region above lateral line with much deep green, the green replaced by golden below the lateral line. Top of head with cross bars of green and red. Green streaks radiating from eyes. Head, $2\frac{1}{2}$; depth, 3; D.XIII, 14; A.III, 6; tubes, 58.
. . . . RHODOCHLORIS, 9.

jj. Dorsal surface rather closely covered with small, round, bronze spots, which extend upon the membrane of the soft dorsal. Series of confluent bronze spots form radiating streaks on sides of head; lower lip and anterior part of maxillary dusky. A few conspicuous spots on base of pectoral. A light spot under last dorsal spine, one on opercular flap. Mandible entirely naked; maxillary with a few scales medially. Preorbital with an anterior and a posterior spine. Interorbital nearly evenly concave, the median groove shallow. Upper three preopercular spines directed backward. Second anal spine $3\frac{1}{2}$ in head. Lower jaw projecting; no symphyseal knob. Head, 3; depth, 3; D.XIII, $13\frac{1}{2}$; A.III, $7\frac{1}{2}$. Pores in lateral line, 44 or 45 . . . . GILLI, 10.

ggg. Preorbital very narrow, its least width less than one-fourth pupil, lobate and without spine. Jaws equal, maxillary reaching beyond middle of pupil; eye $2\frac{4}{5}$ in head, longer than snout or interorbital, whose least width is one-half the orbit. Nuchal spines present. Longest dorsal spines 3 in head, second anal spine $2\frac{2}{3}$ in head. Pectorals short, $1\frac{5}{6}$–2 in head. Snout naked or nearly so. Scales on maxillary and mandible minute and smooth, little evident. Fins with a thick membrane covered with fine scales. Five dark bars on back, two elongate black streaks below lateral line. A black blotch on middle of ventrals, a bar at base of pectoral and in axil. Head, $2\frac{1}{2}$; depth, $2\frac{5}{6}$–3; D.XIII, 13; A.III, 7. Pores in lateral line, 31.
. . . . RUPESTRIS, 11.

ff. Dorsal spines little if any less than half length of head.

l. Mandibles scaled, except about the pores; maxillary evenly scaled. Preorbital with a posterior spine only; interorbital flattish, with a deep median groove, $1\frac{2}{3}$ in orbit; orbit 4 in head; second anal spine $2\frac{2}{3}$–3 in length of head. Peritoneum white or dusky. Spinous dorsal deeply incised, the membrane of the fifth spine meeting the sixth spine near its basal fourth. Highest spine 2–$2\frac{1}{2}$ in head. Head and body intense rose pink. Back and dorsal fin indistinctly marked with raw sienna, fins colored like the body. D. XIII, 13; A. III, 16; tubes in lateral line, 37. . . EOS, 12.

ll. Mandibles entirely naked; maxillary with a few scales above; preorbital with an anterior simple spine, or a pos-

terior sinuate 3 to 4-pointed spine. Interorbital deeply concave with a deep median groove, $1\frac{3}{4}$ in orbit; orbit $3\frac{1}{2}$ in head. Second anal spine $2\frac{1}{5}$ in length of head. Peritoneum very dark, olivaceous above, sides pinkish and golden; four pink spots placed as in *rosaceus* but less distinct. Body above lateral line with numerous well-defined spots of olive green. Fins nearly plain red; base of dorsal spotted with olive. D.XIII, 13; A.III; 6; tubes, 50 .... CHLOROSTICTUS, 13.

aa. Cranial ridges of the adult broken and armed with accessory spines. Gill-rakers short clavate. Accessory scales numerous. Second anal spine little larger or longer than third. Jaws naked. Interorbital with a median groove. Color chiefly deep vermilion. D.XIII, 14; A.III, 7; tubes in lateral line, 50. RUBER, 14.

1. SEBASTOMUS RUFUS (Eigenmann and Eigenmann).

Sebastodes rufus, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Nat. Sci., 2d ser., III., p. 13, 1890 (San Diego); *id.* Proc. U. S. Nat. Mus., XV, 1892, p. 163, 1893 (San Diego); *id.* Ann. N. Y. Acad. Nat. Sci., 1892, p. 355 (San Diego).

HABITAT.—San Diego.

This species is known from the types only. In many of its characters it greatly resembles *Acutomentum*. The parietals are nearly touching for a considerable distance in the single specimen at hand. It is probable that the parietals are normally united and that this species should be placed near *Acutomentum alutum*, Gilbert.

2. SEBASTOMUS MINIATUS (Jordan and Gilbert).

Sebastichthys miniatus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 70, (1881) (Santa Barbara, Monterey, San Francisco); *op. cit.*, p. 455 (San Francisco, Monterey, San Pedro, Santa Barbara).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Monterey, San Francisco).—JORDAN and GILBERT, *l. c.*, p. 57 (Santa Barbara to San Francisco).—JORDAN, Cat. Fish. N. Am., p. 108, 1885.—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 5, 1889 (Cortes Bank).

Sebastodes miniatus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 663, 1882 (San Francisco to San Diego).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 164 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355. (San Diego, Cortes Bank, San Pedro, Santa Barbara, Port Harford, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco.

This species is very abundant in the waters of southern California. The specimens examined are from San Diego and San Francisco.

3. SEBASTOMUS PINNIGER (Gill).

Sebastodes rosaceus, AYERS, Proc. Cal. Acad. Sci., 1862, p. 216, fig. 62 (not *Sebastes rosaceus*, GIRARD).

Sebastosomus pinniger, GILL, Proc. Acad. Nat. Sci., Phila., 1864, pp. 59, 147.

Sebastichthys pinniger, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 72, 455 (1881) (Puget Sound, San Francisco, Monterey).—JORDAN and JOUY, Proc. U. S. Nat. Mus., 1881, p. 8 (Monterey, Neah Bay, San Francisco, Puget Sound).—JORDAN and GILBERT, Proc. U. S. Nat. Mus., IV, 1881, p. 57 (1882) (Monterey northward).—BEAN, *l. c.*, 1881, p. 265 (Puget Sound).—JORDAN, Cat. Fish. N. Am., p. 107, 1885.

Sebastodes pinniger, JORDAN and GILBERT, Syn. Fish. N. Am., p. 662, 1883. (Monterey northward).—EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci. 2d ser., III, p. 16, 1890 (San Diego); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 164 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego to Puget Sound).

HABITAT.—San Diego to Puget Sound.

This species is the northern form of *miniatus*. It is rare in the South but abundant northward.

4. SEBASTOMUS LEVIS (Eigenmann and Eigenmann).

Sebastichthys levis, EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 6, and II, p. 1 (Cortes Bank, San Diego).

Sebastodes levis, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 2d Ser., III, p. 36 (Monterey); *id.*, Proc. U. S. Nat. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Nat. Sci., 1892, p. 355 (San Diego, Cortes Bank).

HABITAT.—San Diego north to San Francisco.

This is the largest of the rock cod, reaching a weight of 30 pounds. It is abundant on the coast of southern California.

5. SEBASTOMUS ÆREUS (Eigenmann and Eigenmann).

Sebastodes æreus, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 2d ser., III, p. 20 (San Diego); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego).

HABITAT.—San Diego.

This species is rather rare at San Diego. In all characters but the parietals the single specimen now in the National Museum agrees with this genus. The parietals are, however, unquestionably united in this specimen. The other specimens we have not been able to examine in this respect. For the present we have thought best to place this species in the genus *Sebastomus*.

6. SEBASTOMUS CONSTELLATUS (Jordan and Gilbert).

Sebastichthys constellatus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 295 and 455 (1881) (Santa Barbara Channel, San Francisco, Monterey).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882).—JORDAN and GILBERT, *l. c.*, p. 57.—JORDAN, Cat. Fish. N. Am., p. 108 (1885).—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 7 (Cortes Bank).

Sebastodes constellatus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 655, 1883 (Coast of California, San Francisco southward).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N.Y. Acad. Sci., 1892, p. 355 (San Francisco, Monterey, Santa Barbara, San Diego).

HABITAT.—San Diego to San Francisco. Abundant.

The specimens examined are from San Diego, Santa Barbara, and San Francisco.

7. SEBASTOMUS UMBROSUS (Jordan and Gilbert).

Sebastichthys umbrosus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., V, 1882, p. 410 (1883) (Santa Barbara).—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California).

Sebastodes umbrosus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 950, 1883 (Santa Barbara).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Santa Barbara).

HABITAT.—Santa Barbara.

This species is known from the types only.

8. SEBASTOMUS ROSACEUS (Girard).

Sebastes rosaceus, GIRARD, Proc. Acad. Nat. Sci., Phila., 1854, p. 146; U. S. Pac. R. R. Surv., VI, 1855, p. 14, pl. XXI (San Francisco); *l. c.*, X, 1858, p. 78, pl. XXI (poor figure from specimen in bad condition).—GÜNTHER, Cat. Fish. Brit. Mus., II, p. 98, 1860 (copied).—LOCKINGTON, Proc. Cal. Acad. Sci., 1876, p. 79 (San Francisco).

Sebastichthys rosaceus, GILL, Proc. Acad. Nat. Sci., Phila., 1862, p. 278.—JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (1881) (San Francisco, Monterey, Santa Barbara).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (San Francisco, Monterey).—JORDAN and GILBERT, *l. c.*, 1881, p. 57 (San Francisco to Santa Barbara).—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California).—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 7, and II, p. 1, 1889 (Cortes Bank, San Diego).

Sebastodes rosaceus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 666, 1882 (Coast of California).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 164 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, Santa Barbara, Monterey, San Francisco).

Sebastes helvomaculatus, AYRES, Proc. Cal. Acad. Sci., II, p. 26, 1859, fig. 8.—LOCKINGTON, Proc. Cal. Acad. Sci., 1876, p. 79 (San Francisco).

HABITAT.—San Diego to San Francisco.

The specimens examined are from San Diego and San Francisco.

9. SEBASTOMUS RHODOCHLORIS (Jordan and Gilbert).

Sebastichthys rhodochloris, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 144 (1881) (Monterey); and p. 455 (San Francisco and Monterey Bay).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882) (San Francisco, Monterey).—JORDAN and GILBERT, *l. c.*, 1881, p. 57 (Monterey and Farallones).—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California).

Sebastodes rhodochloris, JORDAN and GILBERT, Syn. Fish. N. Am., p. 667, 1882 (Monterey and San Francisco).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Monterey, San Francisco).

HABITAT.—Monterey to San Francisco, off the coast.

This species is abundant in the San Francisco markets, where it is confounded with the closely allied *rosaceus*.

10. SEBASTOMUS GILLI (R. S. Eigenmann).

Sebastodes gilli, R. S. EIGENMANN, Amer. Nat., XXV, p. 154, 1891 (Point Loma).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego).

HABITAT.—San Diego, in about 100 fathoms. Known from the types only.

11. SEBASTOMUS RUPESTRIS (Gilbert).

Sebastichthys rupestris, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 76 (1891) (Coast of California, south of Point Conception).

Sebastodes rupestris, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355.

HABITAT.—Off southern California, in deep water. Known only from the collections of the U. S. F. C. steamer *Albatross*.

12. SEBASTOMUS EOS (Eigenmann and Eigenmann).

Sebastodes eos, EIGENMANN and EIGENMANN, Proc. Cal. Acad. Sci., 1890, 2d ser., III, p. 18 (San Diego); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1890, p. 355 (San Diego).

HABITAT.—Off San Diego in deep water; not rare.

13. SEBASTOMUS CHLOROSTICTUS (Jordan and Gilbert).

Sebastichthys chlorostictus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 294 (1881) (Monterey); and p. 455 (San Francisco and Monterey); *op cit.*, 1881, p. 57 (Monterey and Farallones).—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XI, 1888, p. 465 (1889) (San Diego); *id.*, Notes San Diego Biol. Lab., I, p. 7 (San Diego).

Sebastodes chlorostictus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 668, 1882 (Monterey and San Francisco).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, Port Harford, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco; abundant.

14. SEBASTOMUS RUBER (Ayres).

Sebastes ruber, AYRES, Proc. Cal. Acad. Sci., 1854, pp. 5, 7 (San Francisco); *id.*, Proc. Boston Soc. Nat. Hist., 1855, p. 97; *id.*, Proc. Cal. Acad. Sci., 1862, p. 215.—LOCKINGTON, Cal. Acad. Sci., 1876, p. 79.

Sebastichthys ruber, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (1881) (Puget Sound, San Francisco, Monterey, Santa Barbara).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Monterey, San Francisco, Puget Sound).—JORDAN and GILBERT, *l. c.*, 1881, p. 57 (Santa Barbara northward).—BEAN, *l. c.*, 1881, p. 252 (Santa Barbara, Monterey, San Francisco, off Port Bingham, Jacob's Island, Gulf of Alaska) and pp. 269, 271, 472 (Alaska to or beyond San Francisco; Kygani St., Alaska).—JORDAN, Cat. Fishes N. Am., p. 108, 1885 (California).—EIGENMANN and EIGENMANN. Notes San Diego Biol. Lab., I, p. 6, and II, p. 1, 1889 (San Diego).

Sebastodes ruber, JORDAN and GILBERT, Syn. Fish. N. Am., p. 665, 1882 (Pacific Coast, Santa Barbara northward).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 164 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, San Pedro, Monterey, San Francisco, Alaska).

HABITAT.—San Diego to Alaska; abundant, and one of the largest species.

IX. Genus PTEROPODUS, Eigenmann and Beeson.

Pteropodus, EIGENMANN and BEESON, Amer. Nat., July, 1893 (*maliger*).

TYPE.—*Sebastichthys maliger*, JORDAN and GILBERT

This genus is composed of a number of species showing considerable variations in the gill-rakers and in the cranial structure. The gill-rakers are shortest in *rastrelliger* and longest and slenderest in *maliger*. The cranial spines are lowest in *rastrelliger* and highest in *nebulosus*. In the shape of the body *elongatus* is closely related to *saxicolla* and *proriger*. The latter species are long and slender and have

thin pectoral rays. They probably live off the bottom. Those with thickened pectoral rays are, for the most part, heavy, and probably live on the bottom much of the time. The genus approaches *Sebastichthys* in its cranial armature, usually naked branchiostegals and lower jaw, and in the large mucus pores of the lower jaw. It differs from that genus in its separate parietals.

ANALYSIS OF THE SPECIES OF PTEROPODUS.

a. Lower pectoral rays not thickened. Maxillary, mandible, and branchiostegals more or less scaled.

b. Buccal and gill cavities and peritoneum jet black. Pale below, dusky above, blotched with reddish and black; a blackish blotch on opercle; fins dull reddish, irregularly marked with blackish, caudal mostly red, sometimes with a black terminal bar. Short and deep, heavy anteriorly with slender caudal peduncle. Maxillary reaching beyond pupil, $2\frac{1}{5}$ in head; jaws equal, the lower mostly included, but with a projecting symphyseal knob. Eye, $2\frac{3}{4}$–3 in head; snout, $4\frac{2}{3}$–6. The two lower preopercular spines directed downward and backward, the others back. Two or three strong preorbital spines. Gill-rakers short, 5 in orbit. Highest dorsal spine, $2\frac{1}{3}$ in head. Second anal spine, 2 in head. Scales small, not regularly imbricated, smooth and cycloid, except those on occiput and a few along the lateral line on posterior part of body; snout naked, maxillary and mandible only partly scaled. Head, $2\frac{1}{2}$; depth, 3; D.XIII, 12; A.III, 5; tubes, 40–45. (Gilbert) .... SINENSIS, 1.

bb. Buccal and gill cavity white.

c. Three or four brownish bars on sides, reduced to dorsal blotches in the adult; one on occiput, one including front of dorsal, one under posterior rays of dorsal, one under soft dorsal, and one on back of tail. Conspicuous olive-brown spots on caudal, usually confined to base and upper lobe of fin. Maxillary reaching to posterior margin of pupil, $2\frac{1}{4}$ in head. Eye, $2\frac{3}{4}$–$3\frac{1}{4}$ in head, much longer than snout or interorbital width. Interorbital flattish, without ridges. Preorbital one-third pupil, with two strong triangular lobes ending in spines. Cranial ridges low. Preopercular spines directed backward. Gill-rakers slender, $2\frac{1}{2}$ in orbit. Highest dorsal spine, $2\frac{1}{2}$ in head. Second anal spine, 2–$2\frac{1}{3}$ in head. Scales rough-ctenoid on breast, maxillary, mandible, and snout. Head, $2\frac{2}{5}$–$2\frac{2}{3}$; depth, 3–$3\frac{1}{4}$ in the length. D.XIII, 12 or 13; A.III, 7; tubes, 45. (Gilbert) .... SAXICOLA, 2.

cc. No crossbars.

d. Olive-green, marbled with darker; sometimes brownish; no red anywhere. Body oblong, not tapering rapidly. The lower jaw somewhat projecting. Maxillary extending to beyond pupil, 2 in head. Eye, $3\frac{1}{2}$ in head. Cranial ridges low. Preorbital very narrow, with two stout spines. Second preopercular spine longer and slen-

derer than the others. Interorbital space broad and slightly convex, widened backward, a little depressed on each side next the superocular spine. Gill-rakers slender, 3 in eye. Preorbital scaly; maxillary partly scaly; mandible with some smooth scales. Dorsal deeply emarginate, the highest spine 2 in head. Head, 3; depth, $2\frac{4}{5}$; D.XIII, 14; A.III, 6; Lat. l., 52 .... ATROVIRENS, 3.

dd. Interrupted longitudinal, olive-green bands on the sides over a ground of light red; upper fins blotched with olive, lower pale red. Maxillary reaching to posterior part of orbit, $2\frac{1}{4}$ in head. Eye, $3\frac{1}{3}$ in head; interorbital concave. Gill-rakers about 3 in eye. Highest dorsal spine, $2\frac{2}{4}$ in head. Second anal spine, 2 in head. Peritoneum dusky. Head, $2\frac{2}{3}$; depth, $3\frac{1}{3}$; D.XIII, 13; A.III, 6 .... ELONGATUS, 4.

aa. Lower pectoral rays thick and fleshy.

e. Elongate, lower jaw projecting and with a strong symphyseal knob. Maxillary, mandible, and branchiostegals densely scaled. Light red blotches under third dorsal spine and under the first and last dorsal rays. General color bright light red, mottled above with dusky olive-green; opercle with a dusky blotch; caudal bright red, speckled with dark olive. Mouth small, the short maxillary extending to beyond the middle of the eye, $2\frac{1}{4}$ in head. Eye very large, longer than snout; preorbital narrow. Interorbital convex, nearly as broad as eye. Gill-rakers slender, 2 in orbit. Highest dorsal spine, 3 in head.

f. Second anal spine much longer and stronger than the third, $2\frac{1}{3}$ in the head. Peritoneum black. Head 3; depth $3\frac{1}{2}$; D. XIII, 13; A. III, 7 .... PRORIGER, 5.

ff. Second anal spine shorter than the third; peritoneum white. BREVISPINIS, 6.

ee. Body short and deep; lower jaw scarcely projecting, or, the jaws equal.

g. Gill-rakers long, about 2 in orbit.

h. Peritoneum jet black; dorsal spines low, $2\frac{1}{3}$–$2\frac{1}{2}$ in head. Elongate, caudal peduncle $3\frac{2}{3}$ in depth of body. Maxillary reaching vertical from middle of pupil, $2\frac{1}{3}$ in head. Lower jaw slightly the longer. Eye much longer than snout, 3–$3\frac{1}{4}$ in head. Interorbital somewhat concave, $1\frac{2}{3}$ in diameter of orbit. Preorbital without spines, extremely narrow, its least width two-sevenths pupil. Preopercular spines directed backward. Second anal spine very long, $1\frac{1}{2}$–$1\frac{1}{5}$ in head. Scales rough ctenoid, those on maxillary, mandible, and breast smoother. Five vaguely defined black bars on back. Two black streaks backward from eye, the upper terminating in a conspicuous blotch on opercle. Head $2\frac{4}{5}$; depth $3\frac{1}{3}$; D. XIII, 14 or 15; A. III, 7 or 8; tubes 42 (Gilbert) .... ZACENTRUS, 7.

hh. Peritoneum pale; median part of interorbital with a deep groove.

i. Dorsal spines high, little less than head less opercle, their membranes deeply incised. Jaws equal. Yellowish brown, anterior part of the back and sides usually clear yellow; breast yellow; anterior part of body closely covered

with round spots of orange. Soft fins slaty black, the pectorals and dorsal paler at base and speckled. Head $2\frac{3}{5}$; profile steep; depth $2\frac{1}{4}$. D. XIII, 13; A. III, 6. Tubes in lateral line 47.................... MALIGER, 8.

ii. Dorsal spines moderate, 2 in head; lower jaw projecting. Three straight dark crossbars, one from nape across base of pectoral, one from between sixth and seventh dorsal spines toward anus, a half one from eighth to tenth dorsal spines to lateral line, a broader one below soft dorsal. These bars extend onto the dorsal fin. A few small dark spots on base of pectorals and on shoulder; sides of tail more or less mottled. Dark streaks radiating from eye. Maxillary extending beyond eye, about $2\frac{1}{5}$ in head. Eye equals snout, $3\frac{6}{7}$ in head; considerably more than interorbital width. Interorbital concave; two strong ridges dividing it into a median and two lateral grooves. Preorbital narrow, with two flat processes. Preopercular spines directed backward. Gill-rakers about 2 in orbit. Second anal spine $2\frac{1}{3}$ in head. Maxillary, mandibles, and snout naked. Scales mostly cycloid. Head 3; depth 3; D. XIII, $14\frac{1}{2}$; A. III, $6\frac{1}{2}$.................................... DALLII, 9.

gg. Gill-rakers, four or more in eye.

j. Interorbital nearly flat, the supraocular ridges scarcely raised, cranial ridges all low, the spines directed backward.

k. Gill-rakers higher than wide. Peritoneum white. Dorsal spines 2 in head or longer.

l. Dark brown varied with light brown........ CAURINUS, 10.

ll. Lemon yellow to dark brick red, color variable. Frequently light blotches arranged as in *chrysomelas*. D. XIII, 16; A. III, 6.............................. VEXILLARIS, 11.

kk. Gill-rakers scarcely higher than they are wide. Peritoneum brownish. Dorsal spines about $2\frac{1}{2}$ in head. Blackish green, spotted with darker and with lighter. D. XIII, 13; A. III, 6 .... RASTRELLIGER, 12.

jj. Interorbital deeply concave, the supraocular ridges high. Cranial ridges all high, the spines directed backward and usually upward and outward.

m. Dorsal spine a little more than half length of head; parietal ridges very high; pale blotches on sides, forming a continuous lateral band. Body and fins profusely speckled with pale; dark markings black, pale markings yellow. Head 3; depth $2\frac{3}{4}$; D. XIII, 13; A. III, 7; tubes 49 .... NEBULOSUS, 13.

mm. Dorsal spines not more than half length of head; pale blotches on sides not forming a continuous lateral band. Occipital ridges moderate. A series of four light spots along the base of the dorsals.

n. Pale markings flesh-color; dark markings olivaceous. Scales rougher, cranial ridges lower, parietal spines lower and narrower. Spinous dorsal higher, 2 in head, its membranes more deeply incised than in *chrysomelas* .... CARNATUS, 14.

nn. Pale markings yellow, dark markings blackish. Dorsal spines $2\frac{1}{4}$ in head. Head $2\frac{3}{4}$; depth $2\frac{3}{4}$; D. XIII, 13; A. III, 6; tubes 46 .... CHRYSOMELAS, 15.

1. PTEROPODUS SINENSIS (Gilbert).

Sebastichthys sinensis, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 81 (1891) (Santa Barbara).

Sebastodes sinensis, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Santa Barbara).

HABITAT.—Santa Barbara.

This species is known only from the types collected by the *Albatross*.

2. PTEROPODUS SAXICOLA (Gilbert).

Sebastichthys saxicola, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 78 (1891) (Coast of California south of Point Conception).

Sebastodes saxicola, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Santa Barbara).

HABITAT.—Coast of southern California; known only from the types.

3. PTEROPODUS ATROVIRENS (Jordan and Gilbert).

Sebastichthys atrovirens, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 27, 289, & 455 (1881) (San Diego, Catalina Island, San Pedro, Santa Barbara, San Luis Obispo, Monterey, San Francisco)—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (San Pedro, Santa Barbara, Monterey, San Francisco)—JORDAN and GILBERT, *l. c.*, p. 561 (San Francisco to San Diego)—JORDAN, Cat. Fish. N. Am., p. 107, 1885.

Sebastodes atrovirens, JORDAN and GILBERT, Syn. Fish. N. Am., p. 662, 1883 (Coast of California)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 164 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355, (San Diego, Cortes Bank, Santa Barbara, Port Harford, Monterey, San Francisco).

HABITAT.—Coast of California from San Diego to San Francisco.

We are indebted to Mr. F. C. Test for an examination of the skull of this species.

4. PTEROPODUS ELONGATUS (Ayres).

Sebastes elongatus, AYRES, Proc. Cal. Acad. Sci., 1859, p. 26, fig. 9.

Sebastichthys elongatus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 143 & 455 (1881) (Monterey, San Francisco)—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Monterey, San Francisco)—JORDAN and GILBERT, *l. c.*, p. 56—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California)—EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab. I, p. 7 & II, p. 1, 1889 (Cortes Bank, San Diego).

Sebastodes elongatus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 668, 1883 (Monterey and San Francisco)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 165 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco; abundant.

This is one of the smaller species.

5. PTEROPODUS PRORIGER (Jordan and Gilbert).

Sebastichthys proriger, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 327 and 455 (Monterey, Farallones, San Francisco)—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 8 (1882) (Monterey, San Francisco)—JORDAN and GILBERT, *l. c.*, p. 56, (Monterey and Farallones)—JORDAN, Cat. Fish. N. Am., p. 107, 1885.

Sebastodes proriger, JORDAN and GILBERT, Syn. Fish. N. Am., pp. 661 & 950, 1883 (Coast of California)—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Monterey and San Francisco).

HABITAT.—Monterey to San Francisco.

The specimen recorded by us as *Sebastodes proriger* from San Diego is *Acutomentum macdonaldi*.

6. PTEROPODUS BREVISPINIS (Bean).

Sebastichthys proriger brevispinis, BEAN, Proc, U. S. Nat. Mus., VI, 1883, p. 359, (Hassler Harbor).

Sebastichthys brevispinis, JORDAN, Cat. Fish. N. Am., p. 107, 1885 (Alaska).

Sebastodes proriger, JORDAN and GILBERT, Syn. Fish. N. Am., p. 950, 1883 (Alaska).

HABITAT.—Alaska.

This species replaces *proriger* in Northern waters.

7. PTEROPODUS ZACENTRUS (Gilbert).

Sebastichthys zacentrus, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 77 (1891), (Santa Barbara).

Sebastodes zacentrus, EIGENMANN and EIGENMANN. Ann. N. Y. Acad. Sci., 1892, p. 355 (Santa Barbara).

HABITAT.—Santa Barbara.

This species is known only from the types.

8. PTEROPODUS MALIGER (Jordan and Gilbert).

Sebastichthys maliger, JORDAN and GILBERT, Proc. U. S. Nat. Mus., 1880, III, pp. 322 and 455 (1881), (Farallones, Monterey Bay, Straits of Fuca).—JORDAN and JOUY, Proc. U. S. Nat. Mus., 1881, p. 7 (1882), (Puget Sound, Monterey, San Francisco).—JORDAN and GILBERT, *l. c.*, p. 58 (Monterey northward).—BEAN, *l. c.*, pp. 252, 269, 271–472 (Sitka, Port McLaughlin, B. C.)—BEAN, Proc. U. S. Nat. Mus., VI, 1883, p. 360 (1884), (Safety Cove, B. C.).—JORDAN Cat. Fish. N. Am., p. 108, 1885.

Sebastodes maliger, JORDAN and GILBERT, Syn. Fish. N. Am., p. 673, 1883 (Monterey to Sitka).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Monterey, San Francisco, Puget Sound, Alaska).

HABITAT.—Monterey to Alaska.

This, one of the prettiest of the Scorpænidæ, is not rare at San Francisco. The specimens examined are from that place.

9. PTEROPODUS DALLII (Eigenmann and Beeson).

Pteropodus dallii, EIGENMANN and BEESON, Amer. Nat., 1894, p. 66 (San Francisco).

The single specimen of this species known is 200 mm. long. It belongs to the Indiana University and was probably collected by Mr. W. G. W. Harford, of the University of California. It is labeled *S. auriculatus*, var., and in general appearance it resembles that species. The sculpturing of the skull and absence of coronal spines separate it distinctly from *Auctospina*. In coloration it seems to approach *P. saxicola*, but it differs from that species in the naked snout and mandible, in the grooved interorbital, etc. In its gill-rakers, white peritoneum, grooved

interorbital it approaches *P. maliger*, from which it differs in many features.

We have taken the liberty to name this species for Mr. William Healey Dall, of the U. S. Geological Survey, who has been intimately identified with west-coast zoology for many years.

10. PTEROPODUS CAURINUS (Jordan and Gilbert)

Sebastes caurinus, RICHARDSON, Voy. Sulph., p. 77, pl. 41, fig. 1, 1845.

Sebastichthys caurinus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 455, 466 (1881), (Puget Sound).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (Puget Sound).—JORDAN and GILBERT, Proc. U. S. Nat. Mus. IV, 1881, p. 58 (Puget Sound northward).—BEAN, Proc. U. S. Nat. Mus., IV, 1881, pp. 252, 271, and 472 (1882), (Puget Sound, Old Sitka, Departure Bay, B. C., Rose Harbor, Queen Charlotte Island, Chacan, Alaska); Proc. U. S. Nat. Mus., VI, 1883 p. 360, (Duncans Bay, B. C., Departure Bay, St. Mary Island, Alaska).—JORDAN, Cat. Fish. N. Am., p. 108, 1885.

Sebastodes caurinus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 672, 1883 (Puget Sound to Sitka).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Puget Sound, Alaska).

HABITAT—Puget Sound to Alaska.

11. PTEROPODUS VEXILLARIS (Jordan and Gilbert).

Sebastichthys vexillaris, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 292 (1881), (Santa Barbara Channel).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882), (Monterey, San Francisco).—JORDAN and GILBERT, *l. c.* p. 58 (San Diego to Puget Sound).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XI, 1888, p. 465 (1889), (San Diego).

Sebastichthys caurinus vexillaris, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 455, 466 (1881), (Puget Sound).—JORDAN, Cat. Fish. N. Am., p. 108 (California).

Sebastodes caurinus vexillaris, JORDAN and GILBERT, Syn. Fish. N. Am., p. 672, 1883 (California).

Sebastodes vexillaris, EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892 p. 167 (1893), (San Diego).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Cortes Bank, San Pedro, Santa Barbara, Monterey, San Francisco).

Sebastichthys carnatus, EIGENMANN and EIGENMANN, Notes San Diego Biol. Lab., I, p. 7, 1889 (Cortes Bank) not *carnatus* of JORDAN and GILBERT.

HABITAT.—San Diego to Puget Sound.

Everywhere abundant and very variable. The specimens examined are from San Diego.

12. PTEROPODUS RASTRELLIGER (Jordan and Gilbert).

Sebastichthys rastrelliger, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 296, 455 (1881), (San Francisco, Monterey, San Luis Obispo, Santa Barbara, San Pedro, Santa Catalina Island).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882).—JORDAN and GILBERT, Proc. U. S. Nat. Mus., IV, 1881, p. 58 (1882), (Humboldt Bay).—JORDAN, Cat. Fish. N. Am., p. 108, 1885.

Sebastodes rastrelliger, JORDAN and GILBERT, Syn. Fish. N. Am., p. 671, 1883, (Coast of California).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 167 (1893), (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, San Pedro, Santa Barbara, Port Harford, Monterey, San Francisco).

HABITAT.—San Diego to Humboldt Bay.

This is an aberrant species with very short gill-rakers and very thick lower pectoral rays. In its gill-rakers it approaches some of the species of *Sebastomus*. The specimens are from San Francisco and San Diego.

13. PTEROPODUS NEBULOSUS (Ayres).

Sebastes nebulosus, AYRES, Proc. Cal. Acad. Sci., 1854, p. 5, (San Francisco).—AYRES, Proc. Bost. Soc. Nat. Hist., 1854, p. 96.

Sebastichthys nebulosus, GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 278.—JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455, (Puget Sound, San Francisco, Monterey).—JORDAN and JOUY, Proc. U. S. Nat. Mus., 1881, IV. p. 7 (1882), (Neah Bay, Monterey, San Francisco, Puget Sound).—JORDAN and GILBERT, *l. c.*, p. 58, (Monterey to Puget Sound).—BEAN, Proc. U. S. Nat. Mus., 1881, p. 265, and 1883, p. 360, (Puget Sound, Vancouver Island, near St. Mary Island, Alaska).—JORDAN, Cat. Fish. N. Am., p. 108, 1885.

Sebastodes nebulosus, JORDAN and GILBERT, Syn. Fish. N. Am,, p. 676, 1883 (Vancouver Island to Monterey).—EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355 (Monterey, San Francisco, Puget Sound).

Sebastes fasciatus, GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 146; *id.*, U. S. Pac. R. R. Surv., VI, p. 15, 1855 (San Francisco); *op. cit.*, p. 78, pl. XXII, 1858, (Presidio Bay, San Francisco).—GÜNTHER, Cat. Fish. Brit. Mus., II, p. 104, 1860.

Sebastichthys fasciolaris (LOCKINGTON), JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 297 (1881), (San Francisco).

HABITAT.—Port Harford to Puget Sound.

The specimens examined are from Port Harford.

14. PTEROPODUS CARNATUS (Jordan and Gilbert).

Sebastichthys carnatus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 73, 455 (1881), (Monterey, San Francisco, San Luis Obispo, Santa Barbara, San Pedro).—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882), (San Francisco, Monterey).—JORDAN and GILBERT, *l. c.*, p. 58.—JORDAN, Cat. Fish. N. Am., p. 108, 1885.

Sebastodes carnatus, JORDAN and GILBERT, Syn. Fish. N. Am., p. 674, 1883 (Coast of California).—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV., 1892, p. 168 (1893), (San Diego); *id.*, Ann. N. Y. Acad. Nat. Sci., 1892, p. 355 (San Diego, San Pedro, Santa Barbara, Port Harford, Monterey, San Francisco).

HABITAT.—San Diego to San Francisco.

The specimens examined were collected at San Francisco and San Diego.

15. PTEROPODUS CHRYSOMELAS (Jordan and Gilbert).

Sebastichthys nebulosus, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 73 (1881) (not *S. nebulosus* of AYRES).

Sebastichthys chrysomelas, JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, pp. 455 and 465 (1881) (from San Nicolas to Cape Mendocino)—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 58 (1882) (Santa Barbara, San Francisco).

Sebasticthys carnatus chrysomelas, JORDAN, Cat. Fish. N. Am., p. 108, 1885.

Sebastodes chrysomelas, JORDAN and GILBERT, Syn. Fish. N. Am., p. 672, 1883. (San Francisco to San Diego)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, 1892, p. 167 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, San Pedro, Santa Barbara, Monterey, San Francisco).

Sebastichthys chrysomelas purpureus, EIGENMANN and EIGENMANN. Notes San Diego Biol. Lab. I, p. 8, 1879 (Cortes Bank).

HABITAT.—San Diego to San Francisco. Abundant and variable.

The specimens examined are from San Francisco.

X. Genus AUCTOSPINA (Eigenmann and Beeson).

Auctospina, EIGENMANN and BEESON, Amer. Nat., July, 1893 (*auriculatus*).

TYPE.—*Sebastes auriculatus*, Girard.

This genus is now known from two species. One of these inhabits the shallow bays and generally shallow waters not frequented by other species of this group. The other is as yet known from deep water only, 260 fathoms.

The genus seems to us to be well characterized by the presence of coronal spines, a pair of spines on the frontals anterior to the origin of the parietal ridges. In *auriculatus* there is a blunt knob on the frontals between the coronal spines and the parietal ridges.

ANALYSIS OF THE SPECIES OF AUCTOSPINA.

a. Peritoneum black; maxillary nearly reaching vertical from posterior margin of orbit, $2\frac{1}{4}$ in head; eye large, $3\frac{1}{5}$ in head, much longer than snout or interorbital width; interorbital with a pair of strong ridges. Preopercular spines radiating; highest dorsal spine, $2\frac{1}{2}$ in head; mandible scaled; scales very rough ctenoid, those on breast, branchiostegal rays, and mandible rough. Uniform light below, a narrow black streak along edge of spinous dorsal, the triangular incised portion of membrane above it white (?). Depth, $2\frac{3}{4}$; head, $2\frac{1}{2}$; D. XIII, 13 or 14; A. III, 6. Lat. line, 29........................ AURORA, 1.

aa. Peritoneum white; maxillary reaching beyond eye, $2\frac{1}{8}$ in head; eye, $4\frac{1}{2}$ in head, little longer than snout; interorbital with a median ridge; preopercular spines all directed backward; highest dorsal spine 2 in head; mandible naked; few scales on breast and maxillary. Blackish brown, mottled; flushed brownish red. Depth, $2\frac{1}{2}$; head, $3\frac{1}{5}$; D. XIII, 13; A. III, 7. Lat. line, 45. .... AURICULATUS, 2.

1. AUCTOSPINA AURORA (Gilbert).

Sebastichthys aurora, GILBERT, Proc. U. S. Nat. Mus., XIII, 1890, p. 80 (1891) (Point Conception).

Sebastodes aurora, EIGENMANN and EIGENMANN, Ann. N. Y. Acad. Sci., 1892, p. 355.

HABITAT.—Coast of southern California in deep water.

This species is known only from the *Albatross*' collections.

2. AUCTOSPINA AURICULATUS (Girard).

Sebastes auriculatus, GIRARD, Proc. Acad. Nat. Sci., Phila., 1854, pp. 131, 146; *id.*, U. S. Pac. R. R. Surv., VI, p. 14, 1855 (San Francisco); *id.*, X, p. 80, 1858 (Presidio, San Francisco)—AYRES, Proc. Cal. Acad. Sci., 1862, p. 215, fig. 68.

Sebastichthys auriculatus, GILL, Proc. Acad. Nat. Sci., Phila., 1862, p. 278—JORDAN and GILBERT, Proc. U. S. Nat. Mus., III, 1880, p. 455 (1881) (Puget Sound, San Luis Obispo, Santa Barbara)—JORDAN and JOUY, Proc. U. S. Nat. Mus., IV, 1881, p. 7 (1882) (mouth Russian River, Santa Barbara, San Francisco, Puget Sound)—JORDAN and GILBERT, *l. c.*, p. 58 (Santa Barbara to Puget

Sound)—BEAN, *l. c.*, p. 265 (Vancouver Island)—JORDAN, Cat. Fish. N. Am., p. 108, 1885 (California).

Sebastodes auriculatus, JORDAN and GILBERT, Syn. Fishes N. Am., p. 670, 1882 (Vancouvers to Cerros Island)—EIGENMANN and EIGENMANN, Proc. U. S. Nat. Mus., XV, p. 1892, 167 (1893) (San Diego); *id.*, Proc. U. S. Nat. Mus., XV, 1892, p. 167 (1893) (San Diego); *id.*, Ann. N. Y. Acad. Sci., 1892, p. 355 (San Diego, Santa Barbara, Port Harford, Monterey, San Francisco, Columbia River, Puget Sound).

Sebastes ruber var. *parvus*, AYRES, Proc. Cal. Acad. Sci., 1854, p. 7 (San Francisco).

HABITAT.—San Diego to Puget Sound, in shallow water. Cerros Island.

The specimens examined are from San Diego, Monterey, and San Francisco.

XI. Genus SEBASTOPSIS, Gill.

Sebastopsis, GILL, Proc. Acad. Nat. Sci., Phila., 1862, p. 278 (*polylepis*), 1863, p. 207, Sauvage Nouv. Arch. Mus. (2), 1 p.—Ann. Sci. Nat. (5), XVII, art. 5, 1875 (*minutus*).

TYPE.—*Sebastes minutus*, CUVIER and VALENCIENNES = *Sebastes polylepis*, BLEEKER.

1. SEBASTOPSIS XYRIS, Jordan and Gilbert.

Sebastopsis xyris, JORDAN and GILBERT, Proc. U. S. Nat. Mus., V, 1882, p. 369 (1883) (Cape San Lucas)—JORDAN, Proc. U. S. Nat. Mus., VIII, 1885, p. 387 (1886) (name).

Head, $2\frac{1}{2}$; depth, $3\frac{1}{2}$; D. XIII, 10; A. III, 5; lat. l., 24 (pores). Mouth large, oblique, the maxillary extending to beyond pupil, its length $1\frac{5}{6}$ in head. Jaws naked. Preorbital narrow, its edge lobate, not spinous. Eye about $3\frac{1}{4}$ in head. Cranial ridges very short, sharp, and high. Interorbital space narrow, very deeply concave, with two longitudinal ridges. Preocular, supraocular, postocular, tympanic, parietal, nuchal, and coronal spines present. Suborbital stay forming a sharp elevated ridge, with a sharp spine near its front, under the eye, and another near its junction with the preopercle. Gill rakers very short. Dorsal fin deeply notched, the longest $2\frac{2}{3}$ in head. Second anal spine much longer than third. Vertical fins with bands and blotches of dark brown; a large dark blotch on last dorsal spines. (Jordan and Gilbert.)

HISTORICAL LIST OF SPECIES AND THEIR PRESENT EQUIVALENTS.

1810. *Epinephelus ciliatus*, Tiles=*Sebastosomus ciliatus*.
1811. *Perca veriabilis*, Pallas=*Sebastosomus ciliatus*.
1845. *Sebastes caurinus*, Richardson=*Pteropodus caurinus*.
1854. *Sebastes auriculatus*, Girard=*Auctospina auriculatus*.
1854. *Sebastes melanops*, Girard=*Sebastosomus melanops*.
1854. *Sebastes rosaceus*, Girard=*Sebastomus rosaceus*.
1854. *Sebastes fasciatus*, Girard=*Pteropodus nebulosus*.
1854. *Sebastes nebulosus*, Ayres=*Pteropodus nebulosus*.
1854. *Sebastes ruber*, Ayres=*Sebastomus ruber*.
1854. *Sebastes paucispinis*, Ayres=*Sebastodes paucispinis*.
1854. *Sebastes parvus*, Ayres=*Auctospina auriculatus*.
1859. *Sebastes nigrocinctus*, Ayres=*Sebastichthys nigrocinctus*.
1859. *Sebastes helvomaculatus*, Ayres=*Sebastomus rosaceus*.
1862. *Sebastodes flavidus*, Ayres=*Sebastosomus flavidus*.
1862. *Sebastodes ovalis*, Ayres=*Acutomentum ovalis*.
1864. *Sebastosomus pinniger*, Gill=*Sebastomus pinniger*.
1864. *Sebastosomus simulans*, Gill=*Sebastosomus melanops*.

1880. *Sebastes matzubaræ,* Hilgendorf= ——— *matzubaræ.*
1880. *Sebastes machrochir,* Günther=*Sebastolobus machrochir.*
1880. *Sebastichthys serriceps,* Jordan and Gilbert=*Sebastichthys serriceps.*
1880. *Sebastichthys miniatus,* Jordan and Gilbert=*Sebastomus miniatus.*
1880. *Sebastichthys carnatus,* Jordan and Gilbert=*Pteropodus carnatus.*
1880. *Sebastichthys entomelas,* Jordan and Gilbert=*Primospina entomelas.*
1880. *Sebastichthys rhodochloris,* Jordan and Gilbert=*Sebastomus rhodochloris.*
1880. *Sebastichthys atrovirens,* Jordan and Gilbert=*Pteropodus atrovirens.*
1880. *Sebastichthys rubrivinctus,* Jordan and Gilbert=*Sebastichthys rubrivinctus.*
1880. *Sebastichthys vexillaris,* Jordan and Gilbert=*Pteropodus vexillaris.*
1880. *Sebastichthys chlorostictus,* Jordan and Gilbert=*Sebastomus chlorostictus.*
1880. *Sebastichthys constellatus* Jordan and Gilbert=*Sebastomus constellatus.*
1880. *Sebastichthys rastrelliger,* Jordan and Gilbert=*Pteropodus rastrelliger.*
1880. *Sebastichthys fasciolaris,* Lockington=*Pteropodus nebulosus.*
1880. *Sebastichthys maliger,* Jordan and Gilbert=*Pteropodus maliger.*
1880. *Sebastichthys proriger,* Jordan and Gilbert=*Pteropodus proriger.*
1880. *Sebastichthys chrysomelas,* Jordan and Gilbert=*Pteropodus chrysomelas.*
1881. *Sebastichthys mystinus,* Jordan and Gilbert=*Primospina mystinus.*
1882. *Sebastopsis xyris,* Jordan and Gilbert=*Sebastopsis xyris.*
1882. *Sebastichthys umbrosus,* Jordan and Gilbert=*Sebastomus umbrosus.*
1885. *Sebastichthys brevispinis,* Bean=*Pteropodus brevispinis.*
1889. *Sebastichthys levis,* Eigenmann and Eigenmann=*Sebastomus levis.*
1889. *Sebastichthys purpureus,* Eigenmann and Eigenmann=*Pteropodus chrysomelas.*
1890. *Sebastodes goodei,* Eigenmann and Eigenmann=*Sebastodes goodei.*
1890. *Sebastodes rufus,* Eigenmann and Eigenmann=*Sebastomus rufus.*
1890. *Sebastomus melanostomus,* Eigenmann and Eigenmann=*Acutomentum melanostomus.*
1890. *Sebastodes eos,* Eigenmann and Eigenmann=*Sebastomus eos.*
1890. *Sebastodes æreus,* Eigenmann and Eigenmann=*Sebastomus æreus.*
1890. *Sebastodes serranoides,* Eigenmann and Eigenmann=*Sebastosomus serranoides.*
1890. *Sebastolobus alascanus,* Bean=*Sebastolobus alascanus.*
1890. *Sebastichthys alutus,* Gilbert=*Acutomentum alutus.*
1890. *Sebastichthys rupestris,* Gilbert=*Sebastomus rupestris.*
1890. *Sebastichthys zacentrus,* Gilbert=*Pteropodus zacentrus.*
1890. *Sebastichthys saxicola,* Gilbert=*Pteropodus saxicola.*
1890. *Sebastichthys diplaproa,* Gilbert=*Sebastichthys diplaproa.*
1890. *Sebastichthys aurora,* Gilbert=*Auctospina aurora.*
1890. *Sebastichthys introniger,* Gilbert=*Acutomentum melanostomum.*
1890. *Sebastichthys sinensis,* Gilbert=*Pteropodus sinesis.*
1891. *Sebastodes gilli,* R. S. Eigenmann=*Sebastomus gilli.*
1893. *Acutomentum macdonaldi,* Eigenmann and Beeson=*Acutomentum macdonaldi.*
1893. *Pteropodus dallii,* Eigenmann and Beeson=*Pteropodus dallii.*

SYSTEMATIC LIST OF THE SPECIES OF SCORPÆNIDÆ, BASED UPON THE PRESENT REVISION.

I. SEBASTOLOBUS, Gill.

Sebastolobus macrochir (Günther).
Sebastolobus alascanus, Bean.

II. SEBASTICHTHYS, Gill.

Sebastichthys nigrocinctus (Ayres).
Sebastichthys serriceps, Jordan and Gilbert.
Sebastichthys rubrivinctus, Jordan and Gilbert.
Sebastichthys diploproa, Gilbert.

III. ACUTOMENTUM, Eigenmann and Beeson.
Acutomentum melanostomum (Eigenmann and Eigenmann)
Acutomentum macdonaldi, Eigenmann and Beeson.
Acutomentum ovalis (Ayres).
Acutomentum alutum (Gilbert).

IV. PRIMOSPINA, Eigenmann and Beeson.
Primospina mystinus (Jordan and Gilbert).
Primospina entomelas (Jordan and Gilbert).

V. SEBASTOSOMUS, Gill.
Sebastosomus flavidus (Ayres).
Sebastosomus serranoides (Eigenmann and Eigenmann).
Sebastosomus melanops (Girard).
Sebastosomus ciliatus (Tiles).

VI. SEBASTODES, Gill.
Sebastodes goodei, Eigenmann and Eigenmann.
Sebastodes paucispinis (Ayres).

VII. GENUS ALLIED TO SEBASTOMUS.
? *matzubaræ*, Hilgendorf.

VIII. SEBASTOMUS, Gill.
Sebastomus capensis (Linnæus).
Sebastomus rufus (Eigenmann and Eigenmann).
Sebastomus miniatus (Jordan and Gilbert).
Sebastomus pinniger (Gill).
Sebastomus levis (Eigenmann and Eigenmann).
Sebastomus æreus (Eigenmann and Eigenmann).
Sebastomus constellatus (Jordan and Gilbert).
Sebastomus umbrosus (Jordan and Gilbert).
Sebastomus rosaceus (Girard).
Sebastomus rhodochloris (Jordan and Gilbert).
Sebastomus gilli (R. S. Eigenmann).
Sebastomus rupestris (Gilbert).
Sebastomus eos (Eigenmann and Eigenmann).
Sebastomus chlorostictus (Jordan and Gilbert).
Sebastomus ruber (Ayres).

IX. PTEROPODUS, Eigenmann and Beeson.
Pteropodus sinensis (Gilbert).
Pteropodus saxicola (Gilbert).
Pteropodus atrovirens (Jordan and Gilbert).
Pteropodus elongatus (Ayres).
Pteropodus proriger (Jordan and Gilbert).
Pteropodus brevispinis (Bean).
Pteropodus zacentrus (Gilbert).
Pteropodus maliger (Jordan and Gilbert).
Pteropodus dallii, Eigenmann and Beeson.
Pteropodus caurinus (Jordan and Gilbert).
Pteropodus vexillaris (Jordan and Gilbert).
Pteropodus rastrelliger (Jordan and Gilbert).
Pteropodus nebulosus (Ayres).
Pteropodus carnatus (Jordan and Gilbert).
Pteropodus chrysomelas (Jordan and Gilbert)

X. AUCTOSPINA, Eigenmann and Beeson.
Auctospina aurora (Gilbert).
Auctospina auriculatus (Girard).

XI. SEBASTOPSIS, Gill.
Sebastopsis xyris, Jordan and Gilbert.

ADDITIONAL NOTES ON THE NATIVE TREES OF THE LOWER WABASH VALLEY.

By Robert Ridgway.

Since the publication of my "Notes on the Native Trees of the Lower Wabash and White River Valleys in Illinois and Indiana," * and the additions and corrections to the same article,† a considerable amount of further information has been gathered, partly through my own observations during occasional visits to that region, but chiefly through investigations made by Dr. J. Schneck, of Mount Carmel, Ill., who having been appointed by the State authorities to make an exhibit of Illinois woods at the New Orleans Exposition, was enabled to take measurements of many species which, for one reason or another, I had not measured. Dr. Schneck having kindly furnished me with these measurements and given me permission to publish them, they are presented in the following notes, except in those cases where figures already published are not affected.

After the lapse of so many years, it is to be expected that additions are to be made to the list, that some statements are to be modified, and that errors are to be corrected. These will be found under appropriate headings at the end of this paper.

Before proceeding to take up the species in regular order, it may be well to explain that the first number corresponds with the numeration of my first paper, while the number in parentheses prefixed to the name of a species corresponds in each case with that given in the octavo edition of Prof. Sargent's "Catalogue of the Forest Trees of North America," published in 1880, ‡ and not with the numeration of the large quarto "Report on the Forests of North America (exclusive of Mexico)," published in 1884.

* Proc. U. S. Nat. Mus., v, 1882, pp. 49–88, (1883). (Actual date of publication of edition of "separates," June 12, 1882.)

† Additions and corrections to the list of native trees of the Lower Wabash Valley. Botanical Gazette, VIII, No. 12, Dec. 1883, pp. 345–352.

‡ Sargent, Charles S.—A Catalogue of the Forest Trees of North America; Tenth Census of the United States, Govt. Printing Office, Washington, 1880.

§ Sargent, Charles S.—Report on the Forests of North America (exclusive of Mexico); Tenth Census of the United States, IX, Govt. Printing Office, Washington, 1884.

Measurements of girth are always taken above the swell at the base of the tree, or at a height usually of 2 to 4 feet, though sometimes 5 or 6 feet from the ground. The height is always measured from a felled tree with a 100-foot tapeline. Unless otherwise stated, all trees measured were found in the immediate vicinity (within 3 miles radius) of Mount Carmel, Ill., though sometimes on the opposite side of the Wabash River, in Knox and Gibson counties, Indiana.

2. (8.) LIRIODENDRON TULIPIFERA, Linnæus. Tulip Tree; "Poplar."

A large poplar cut for shingles 8 miles east of Vincennes measured 8 feet across the top of the stump, which was solid to the center; the last cut was 63 feet from the first, and the trunk made 80,000 shingles.

3. (10.) ASIMINA TRILOBA (Linnæus) Dunal. Pawpaw.

The largest specimen measured by Dr. Schneck was 48 feet high and 27 inches in circumference.

4. (14.) TILIA AMERICANA, Linnæus. American Linden. "Lin."

Dr. Schneck's largest measurements are, girth, 17½ feet; height, 135 feet.

6. (—.) "ILEX VERTICILLATA. Black Alder."

This should read "*Ilex decidua*, Walter. Deciduous Holly." *I. verticillata* occurs also, but it is only a shrub.

7. (40.) ÆSCULUS GLABRA, Willdenow. Smooth Buckeye.

A tree of this species measured by Dr. Schneck was 83 feet high and 35 inches in circumference.

11. (53.) NEGUNDO NEGUNDO (Linnæus) Karsten. Box Elder.

A tree measured by Dr. Schneck was 60 feet high and 9½ feet in circumference.

13. (—.) RHUS GLABRA, Linnæus. Smooth Sumac.

Dr. Schneck measured a specimen of this species which was 20 feet high and 9 inches in girth.

16. (65.) GYMNOCLADUS DIOICUS (Linnæus) Koch. Coffee-bean; Coffee-nut.

Height, 129 feet; circumference, 7½ feet, are the dimensions of a tree measured by Dr. Schneck.

17. (66.) GLEDITSIA AQUATICA, Marshall. Water Locust.

The known size which this tree attains is considerably increased by Dr. Schneck's measurements, which show that a height of 90 feet is sometimes reached, the specimen measured being only 4¾ feet in circumference.

18. (67.) GLEDITSIA TRIACANTHOS, Linnæus. Honey Locust.

The largest specimen measured by Dr. Schneck was 156 feet high and 18 feet in circumference.

19. (58.) ROBINIA PSEUDACACIA, Linnæus. Black Locust.

A cultivated specimen, growing in Wabash County, Ill., measured by Dr. Schneck, was 95 feet high and 11½ feet in circumference.

21. (76.) PRUNUS AMERICANA, Marshall. Wild Plum.

The tree from which Dr. Schneck's specimens of the wood were taken measured 28 feet high and 27 inches in circumference.

22. (78.) PRUNUS ANGUSTIFOLIA, Marshall. Chickasaw Plum.

Dr. Schneck's specimen was 20 feet high and 21 inches in circumference.

23. (81.) PRUNUS SEROTINA, Ehrmann. Wild Cherry.

A wild-cherry tree measured by Dr. Schneck was 135 feet high by 10½ feet in circumference.

25. (87.) PYRUS CORONARIA, Linnæus. Crab Apple.

Dr. Schneck's specimen was 28 feet high and 26 inches in circumference.

28. (96.) CRATÆGUS CRUS-GALLI, Linnæus. Cockspur Thorn.

Height, 32 feet; circumference, 20 inches (Schneck).

30. (102.) CRATÆGUS TOMENTOSA, Linnæus. Black Thorn.

Height, 29 feet; circumference, 21 inches (Schneck).

31. (105.) AMELANCHIER CANADENSIS, Medicus. June Berry.

Height, 38 feet; circumference, 28 inches (Schneck).

32. (106.) LIQUIDAMBAR STYRACIFLUA, Linnæus. Sweet Gum.

Articles describing this species refer to the corky excrescences to the branchlets as if they were a constant feature. So far is this from being true that it is probably no exaggeration to say that not 5 per cent. of the total number of trees possess them, or at least they are not conspicuously developed in a greater proportion. Indeed, so far as my observation goes (and I have examined many hundred trees), these excrescences are decidedly exceptional.

37. (124.) VIBURNUM PRUNIFOLIUM, Linnæus. Black Haw.

Height, 21 feet; circumference, 11 inches (Schneck).

41. (154.) FRAXINUS PUBESCENS, Lamarck. Red Ash.

Height, 138 feet; circumference, 16 feet (Schneck).

44. (157.) FRAXINUS VIRIDIS, Michaux, f. Green Ash.

Height, 92 feet; circumference, 5 feet (Schneck).

45. (165.) CATALPA SPECIOSA, Warder. Catalpa.

While near Fairfield, Wayne county, Ill., in May, 1890, I was shown a number of small but flourishing catalpa trees which had sprouted from fence posts. The latter had been split and put into the ground while green and sprouted at the ground, the sprouts forming well-shaped trees 10–15 feet high with stems of proportionate thickness. I supposed they had been planted inside the fence, and would not have suspected their curious origin had not my attention been called to it.

47. (176.) ULMUS ALATA, Michaux. Winged Elm.

Height, 55 feet; circumference, 27 inches (Schneck). In the town of Fairfield, Wayne county, Ill., are some beautiful examples of this handsome tree planted as shade trees along some of the streets. They have assumed a symmetrical spreading form and display conspicuously the curious corky winged appendages to the branches. This species is abundant in bottom lands of Wayne, Richland, Edwards, and adjoining counties in Illinois.

49. (179.) ULMUS PUBESCENS, Walter. Slippery Elm.

A tree measured by Dr. Schneck was 83 feet high and 7⅓ in circumference.

50. (183.) CELTIS MISSISSIPPIENSIS, Bosc. Mississippi Hackberry.

This is surely a distinct species from *C. occidentalis* in the region under consideration, being always easily distinguished by the conspicuously different foliage, bark, and fruit—the latter not only different in size but in color also. I found it abundant in creek bottoms in the southern portion of Richland county, Ill., where some of the trees were taller than I had seen them elsewhere, apparently 100 feet or more in height.

A specimen measured by Dr. Schneck was 95 feet high and 5½ in circumference.

59. (202.) HICORIA GLABRA (Miller) Britton. Pig-nut; Broom Hickory.

Height, 120 feet; circumference, 8½ feet (Schneck).

60. (203.) HICORIA SULCATA (Willdenow) Britton. Big Shell-bark; Bottoms Shell-bark.

Height, 119 feet; circumference, 8 feet (Schneck).

—. (200.) HICORIA AQUATICA, Michaux, f. Water Hickory.

This species was not included in my list, although referred to in the introduction (p. 50) as having been, with *H. myristicæformis*, mentioned by Prince von Wied, in the list of trees observed by him at New Harmony, Ind.* Under date of December 15, 1883, Dr. Vasey wrote me

* *Reise in das innere Nord-amerika*, I, p. 209.

that he had lately received specimens of *H. aquatica* from Mr. W. F. Fortune, collected at Equality, Gallatin county, Ill., adding that it was sent to him as *H. Pecan*, "which the foliage much resembles, but the nuts are much flattened, and ridged, and the meat is as bitter as that of *H. minima*."

In view of this virtual confirmation of Prince von Wied's record of *H. aquatica*, *H. myristicæformis* should be looked for in the lower Wabash bottom-lands.

65. (218.) QUERCUS DIGITATA (Marshall) Sudworth. Spanish Oak.

A specimen of this oak measured by Dr. Schneck was 97 feet high and 6 feet in circumference.

In the White River bottoms there occurs a very strongly marked variety of this species or possibly a tree that is specifically distinct, distinguished from the true *Q. digitata*, which is especially a tree of thin-soiled uplands, by its much larger and taller growth and distinctly light-colored bark. In fact, although it has the bristle-pointed, acute-lobed leaves of the black-oak group, and moreover has the lobes shaped as in *Q. digitata* and the under surface of the leaves densely tomentose as in that species, the bark of the trunk is so light-colored as to cause the tree to be easily mistaken for one of the white oaks, as, for example, *Q. alba or Q. Muhlenbergii*, which it further resembles in habit. So very different is it, in these particulars, from *Q. digitata* that I feel quite certain it will prove, on investigation, to be at least subspecifically distinct.

The first specimen met with by me was growing in the White River bottoms, about five miles above the mouth of that stream, on the southern side. It measured 14 feet in circumference, with the trunk free of branches for at least 70 feet, but rather crooked. Other trees quite identical in characters were afterward examined by Dr. Schneck and myself near White River Pond, several miles southwest of the tree above mentioned, but neither of us have seen it elsewhere than in the bottom-lands lying between the extreme lower portions of White and Patoka rivers, where the typical black-barked *Q. digitata* seems not to occur at all, being, as previously stated, apparently confined to thin-soiled or clayey uplands.

66. (222.) QUERCUS IMBRICARIA, Michaux. Laurel Oak; Shingle Oak.

Height, 100 feet; circumference, 8 feet (Schneck).

67. (226.) QUERCUS LYRATA, Walter. Swamp Post Oak; Overcup Oak.

This tree grows in the bottoms of all the streams tributary to the Wabash, at least as far north as Jasper county, Ill., where I found it in the vicinity of Rafe's mill, in July, 1887. In Fox River bottoms,

immediately west of Sugar Creek prairie, Richland county, this oak was the prevailing species over considerable areas of swampy woods.

69. (I.) QUERCUS MICHAUXI, Nuttall. Michaux's Oak; Basket Oak.

More recent investigations have shown this tree to be a common one in rich bottom-lands, and certainly specifically distinct (in our district) from *Q. platanoides* (*Q. bicolor*).

70. (228.) QUERCUS MUHLENBERGII, Engelmann. Yellow Oak; "Chinquapin."

Height, 155 feet; circumference, 12 feet (Schneck).

71. (229.) QUERCUS NIGRA, Linnæus. Black Jack; Jack Oak.

Height, 65 feet; circumference, 3½ feet (Schneck).

75. (235.) QUERCUS MINOR (Marshall) Sargent. Post Oak.

While my estimate of "about 50 to 80 feet high, and 2 to 3 feet in diameter" as the "usual size of the heavier growth" is probably very nearly correct, larger trees occur, one measured by Dr. Schneck being 103 feet high and 10 in circumference.

79. (244.) OSTRYA VIRGINIANA (Miller) Willdenow. Hop Hornbeam.

Height 25 feet, girth 26 inches (Schneck).

82. (249.) BETULA NIGRA, Linnæus. Red Birch; River Birch.

Height 105 feet, circumference 10 feet (Schneck).

84. (—.) SALIX DISCOLOR, Muhlenberg. Glaucous Willow.

Height 15 feet, circumference 9 inches (Schneck).

—. (—.) SALIX LONGIFOLIA, Muhlenberg. Long-leafed Willow; Sand-bar Willow.

Height 70 feet, circumference 20 inches (Schneck).

85. (261.) SALIX NIGRA, Marshall. Black Willow.

My maximum measurement of 87½ feet is exceeded by one by Dr. Schneck of a tree which was 95 feet high and 7½ feet in circumference.

88. "POPULUS TREMULOIDES. Aspen; Quaking-Asp." (= *P. grandidentata* Michaux. Large-toothed Aspen!).

Dr. Schneck measured a tree of this species which was 97 feet high and 4⅔ feet in circumference.

P. tremuloides apparently does not occur in our region.

89. (277.) JUNIPERUS VIRGINIANA, Linnæus. Red Cedar.

A specimen growing in Saline County, Ill., measured by Dr. Schneck, was 75 feet high and 5 feet in circumference.

90. (—.) JUNIPERUS COMMUNIS, Linnæus. Juniper.

A Saline County specimen measured by Dr. Schneck was 25 feet high and 18 inches in circumference.

APPENDIX.

A.—NUMBER OF SPECIES OF NATIVE TREES ASCERTAINED TO OCCUR INDIGENOUSLY IN THE LOWER WABASH VALLEY.

The total number of species given in my catalogue is 94; but from this number the following are to be deducted, as being more properly classed as shrubs than trees:

1. *Rhus glabra.* Smooth Sumac.
2. *Amorpha fruticosa.* False Indigo.
3. *Viburnum dentatum.* Arrow-wood.
4. *Salix lucida.* Shining Willow

The number would thus seem to be reduced to 90; but the additions far outnumber the reductions, the following having been omitted from my list:

*1. *Ptelea trifoliata,* Linnæus. Hop Tree.
*2. *Euonymus atropurpureus,* Jacquin. Burning Bush; Wahoo.
3. *Rhamnus Caroliniana,* Walter. Carolina Buckthorn.
4. *Æsculus octandra,* Marshall. Sweet Buckeye.
5. *Rhus Vernix,* Linnæus. Poison Sumac; Poison Dogwood; Poison Elder.
*6. *Cratægus spathulata,* Michaux. Small-fruited Haw.
*7. *Hamamelis Virginica,* Linnæus. Witch Hazel.
8. *Nyssa aquatica,* Marshall. Tupelo.
9. *Vaccinium arboreum,* Marshall. Farkle-berry.
10. *Bumelia lanuginosa,* Persoon. Gum Elastic; Shittim wood.
11. *Bumelia lycioides,* Gærtner. Southern Buckthorn.
12. *Mohrodendron tetraptera* (Linnæus) Britton. Silver-bell Tree; Snow-drop Tree; Calico-wood.
*13. *Forestiera acuminata,* Poiret. Water Privet.
14. *Planera aquatica,* Gmelin. Water Elm.
15. *Hicoria aquatica* (Michaux. f.) Britton. Water Hickory.
16. *Castanea pumila* (Linnæus) Miller. Chinquapin.
*17. *Salix longifolia,* Muhlenberg. Sandbar Willow.

Of the above, those marked with an asterisk have been identified in the immediate vicinity of Mount Carmel, the others being mainly more southern, or occurring only farther down the river. No. 6, *Cratægus spathulata*, is not included in Dr. Schneck's list and has not been met with by him or myself during recent years. Specimens in fruit were found by us, however, near Mauck's Pond, Gibson County, Ind., in September, 1871.* There is some doubt as to No. 16, *Castanea pumila*, which is given on Prof. Sargent's authority; but there is a possibility of an error having been made from the circumstance that the name "chinquapin" is in that region almost universally applied to the fruit of *Quercus Muhlenbergii*.

* See American Naturalist, December, 1872, p. 728.

The actual number of indigenous species of trees in the Lower Wabash Valley (from the mouth of White River southward) would thus appear to be 107, but the total may be still larger through the probable addition of *Ilex opaca*, quoted from southern Indiana, *Cratægus arborescens* (Union and Jackson counties, Ill.), *Hicoria myristicæformis* (Posey County, Ind., *fide* Prince von Wied), and a few of more general distribution (as *Ulmus racemosa*) which have not yet been reported from the area under consideration.

B.—NUMBER OF SPECIES GROWING IN RESTRICTED AREAS.

Some interesting additions, or additional observations, may be made to the lists given on pages 50 to 53 of my catalogue. Regarding list "(2)", for example (pp. 52, 53), it may be stated that the piece of woods in question consisted wholly of low flat ground, much of it under water in wet weather. Much valuable timber had been culled over the whole area, while from considerable portions nearly all the large growth had been destroyed, two species (the Western Catalpa and Black Walnut, easily identified from the stumps) having in fact been quite exterminated. If these latter had been still growing, the total number of species growing on the 75 acres would apparently be 54, instead of 52, as given in the list. A subsequent examination, however, revealed the presence of two additional species, viz: *Fraxinus quadrangulata* (Blue Ash), and *Hicoria microcarpa* (Little Shellbark), making the actual total 56 species. During a later examination (made in October, 1882), which was restricted to 22 acres of the same piece of woods, no less than 43 species of trees were detected, notwithstanding one piece of 8 acres had been wholly deprived of the undergrowth and most of the large trees, while more or less timber had been cut from the whole tract. This gives about two additional species of trees for each separate acre of the whole area. The species noted are the following:

1. *Liriodendron tulipifera*. Common.
2. *Asimina triloba*. Common.
3. *Acer rubrum*. Common.
4. *Acer saccharum*. Common.
5. *Rhus copallina*. Common, growing 20 to 30 feet high.
6. *Gleditsia triacanthos*. A few small trees.
7. *Gymnocladus dioicus*. A few small trees.
8. *Cercis Canadensis*. Common.
9. *Prunus Americana*. Common.
10. *Prunus serotina*. Rare.
11. *Liquidambar Styraciflua*. Common.
12. *Cornus florida*. Common.
13. *Nyssa sylvatica*. Common.
14. *Viburnum prunifolium*. Abundant.
15. *Diospyros Virginiana*. Common.
16. *Fraxinus Americana*. Common.
17. *Fraxinus quadrangulata*. Common.
18. *Sassafras sassafras*. Common.
19. *Ulmus Americana*. Abundant.
20. *Ulmus pubescens*. Common.
21. *Celtis occidentalis*. A few small trees.
22. *Morus rubra*. Common.
23. *Platanus occidentalis*. Common.
24. *Hicoria ovata*. Abundant.
25. *Hicoria microcarpa*. Common.
26. *Hicoria sulcata*. Common.
27. *Hicoria alba*. Common.
28. *Hicoria glabra*. Common.
29. *Hicoria minima*. Common.
30. *Quercus alba*. Abundant.
31. *Quercus platanoides*. Common.
32. *Quercus macrocarpa*. Rather common.
33. *Quercus coccinea*. Common.

34. *Quercus velutina.* Common.
35. *Quercus rubra.* Common.
36. *Quercus palustris.* Common.
37. *Quercus imbricaria.* Common.
38. *Fagus atropunicea.* Common.
39. *Carpinus Virginiana.* Common.
40. *Salix nigra.* Most abundant tree along edge of swamp.
41. *Populus heterophylla.* Abundant along edge of swamp.
42. *Populus monilifera.* Common along edge of swamp.
43. *Populus grandidentata.* Sparingly scattered through woods.

On a tract of 40 acres, partly cleared, 1 mile southeast of Olney, Richland County, Ill., the following species were recognized during an imperfect survey of the woods:

1. *Asimina triloba.* Common.
2. *Acer saccharinum.* Common.
3. *Acer rubrum.* Rare?
4. *Acer saccharum.* Common.
5. *Gleditsia triacanthos.* Common.
6. *Cercis Canadensis.* Abundant.
7. *Prunus Americana.* Common.
8. *Prunus serotina.* Common.
9. *Pyrus coronaria.* Common.
10. *Cornus florida.* Abundant.
11. *Nyssa sylvatica.* Common.
12. *Diospyros Virginiana.* Common.
13. *Fraxinus quadrangulata.* Common.
14. *Catalpa speciosa.* Common.
15. *Sassafras sassafras.* Common.
16. *Ulmus Americana.* Common.
17. *Ulmus pubescens.* Common.
18. *Morus rubra.* Rather common.
19. *Platanus occidentalis.* Common.
20. *Juglans nigra.* Common.
21. *Hicoria ovata.* Common.
22. *Hicoria minima.* Common.
23. *Hicoria glabra.* Common.
24. *Hicoria alba.* Abundant.
25. *Quercus alba.* Abundant.
26. *Quercus platanoides.* Rather common.
27. *Quercus minor.* Common on high grounds with thin soil.
28. *Quercus macrocarpa.* Common.
29. *Quercus coccinea.* Common.
30. *Quercus velutina.* Common.
31. *Quercus rubra.* Common.
32. *Quercus palustris.* Common.
33. *Quercus imbricaria.* Abundant.
34. *Betula nigra.* Rather common along bank of stream.
35. *Salix nigra.* Rather common in wet places.
36. *Populus monilifera.* Rather common along bank of stream.

For the sake of comparison of variety of tree-growth between the foregoing Mississippi Valley localities and localities of equal or greater area east of the Alleghanies, in the same latitude, the following lists are presented:

(*1*) *Near Falls Church, Fairfax County, Va.; locality, a 200-acre farm and vicinity.*

1. *Liriodendron tulipifera.* Common.
*2. *Ilex opaca.* Rare.
3. *Acer rubrum.* Common.
*4. *Robinia pseudacacia.* Abundant, but perhaps spread from cultivation.
5. *Prunus serotina.* Rather common.
6. *Cornus florida.* Abundant.
7. *Nyssa sylvatica.* Rather common.
8. *Diospyros Virginiana.* Common.
*9. *Chionanthus Virginica.* Rather common.
10. *Fraxinus* (*Americana?*). Rare.
11. *Sassafras sassafras.* Abundant.
12. *Ulmus Americana.* Rare.
13. *Juglans nigra.* Very rare.
14. *Hicoria alba.* Rather common.
15. *Quercus alba.* Abundant.
16. *Quercus platanoides.* Common on low grounds.
*17. *Quercus prinus.* Abundant on high grounds.
*18. *Quercus Phellos.* Common on low grounds.
19. *Quercus nigra.* Common on high grounds.
20. *Quercus digitata.* Common on high grounds.
21. *Quercus rubra.* Rather common.

22. *Quercus velutina.* Rather common.
23. *Quercus palustris.* Common.
*24. *Castanea dentata.* The most abundant tree on higher grounds.
*25. *Castanea pumila.* Abundant.
*26. *Juniperus Virginiana.* Abundant.
*27. *Pinus rigida.* Common.
*28. *Pinus Virginiana.* Abundant, often covering almost exclusively considerable areas.

The species marked with an asterisk are not included in any of the western lists. Two of them (Nos. 9 and 25) did not assume the size and scarcely the habit of trees, and ought, in fairness, to be omitted.

(2) *Bottoms of the Patuxent River, Maryland, from Laurel 4 miles southward.*

*1. *Magnolia glauca.* Common locally.
2. *Liriodendron tulipifera.* Abundant.
3. *Asimina triloba.* Common locally.
*4. *Ilex opaca.* Common.
5. *Acer saccharinum.* Rare.
6. *Acer rubrum.* Very abundant.
*7. *Robinia pseudacacia.* Common on higher grounds but perhaps escaped from cultivation.
8. *Prunus Americana.* Rare.
9. *Prunus serotina.* Rather rare.
10. *Pyrus coronaria.* Rare.
11. *Cratægus Crus-galli.* Rare.
12. *Amelanchier Canadensis.* Rare.
13. *Liquidambar Styraciflua.* Very abundant.
14. *Cornus florida.* Abundant.
15. *Nyssa sylvatica.* Common.
16. *Viburnum prunifolium.* Occasional.
17. *Diospyros Virginiana.* Common.
18. *Fraxinus Americana.* Rare.
19. *Sassafras sassafras.* Common.
20. *Ulmus Americana.* Rather rare.
21. *Morus rubra.* Rather rare.
22. *Platanus occidentalis.* Common.
23. *Juglans nigra.* Rare.
24. *Hicoria alba.* Rather common.
25. *Hicoria glabra.* Occasional.
26. *Hicoria minima.* Occasional.
27. *Betula nigra.* Common.
28. *Carpinus Caroliniana.* Abundant.
29. *Quercus alba.* Common.
30. *Quercus minor.* Occasional on uplands.
31. *Quercus lyrata.* Common locally.
32. *Quercus platanoides.* Common.
33. *Quercus Michauxi.* Common locally.
*34. *Quercus prinus.* Common on uplands.
35. *Quercus rubra.* Common.
36. *Quercus velutina.* Common.
37. *Quercus palustris.* Abundant.
38. *Quercus digitata.* Common on uplands.
39. *Quercus nigra.* Common on uplands.
40. *Quercus phellos.* Abundant.
*41. *Castanea dentata.* Abundant on uplands.
42. *Fagus atropunicea.* Common locally.
43. *Salix nigra.*
44. *Populus grandidentata.* Occasional on uplands.
*45. *Pinus rigida.* Common.
*46. *Pinus Virginiana.* Abundant.
*47. *Juniperus Virginiana.*

The above seemingly large list includes every species of tree which I was able to recognize in any portion of the extensive area (at least 5 square miles), which included besides ordinary bottom land, swamps and uplands, with varying conditions of soil. If the count had been restricted to an area of say 100 acres, in any portion of the larger area, the list would have been reduced about one-third. The district having been carefully explored on very numerous occasions (much more thoroughly than I have been able to explore any western tract of equal extent), it is probable that the list is very nearly complete.

C.—CLASSIFIED MEASUREMENTS.

(*1*) *Additions to the "list of trees attaining a height of 100 feet or more."*

No.	Species.	Maximum ascertained height.	Girth of tree measured.
35	Quercus Michauxi	119 feet (R. R.)	13 feet.
36	Quercus minor	103 feet (J. S.)	10 feet.
37	Hicoria glabra	115 feet (R. R.); 120 feet (J. S.).	7½ feet (R. R.); 8½ feet (J. S.).
38	Hicoria microcarpa	134 feet (R. R.)	9 feet 10 inches.
39	Hicoria sulcata	119 feet (J. S.)	8 feet.
40	Betula nigra	105 feet (J. S.)	10 feet.
41	Prunus serotina	135 feet (J. S.)	10½ feet.
42	Fraxinus pubescens	138 feet (J. S.)	16 feet.

(*2*) *Increased maximum height as determined by subsequent measurements.*

Numeration of original list.	Species.	Maximum height as given in original list.	Maximum height by subsequent measurements.
2	Tilia Americana	130 feet (R. R.)	135 feet (J. S.).
6	Gymnocladus dioicus	109 feet (R. R.)	129 feet (J. S.).
7	Gleditsia triacanthos	137 feet (R. R.)	156 feet (J. S.).
15	Celtis occidentalis	134 feet (R. R.)	136 feet (J. S.).
28	Quercus Muhlenbergii	122½ feet (R. R.)	155 feet (J. S.).
19	Quercus palustris	120 feet (J. S.)	135 feet (J. S.).

(*3*) *Trees which apparently do not reach a maximum height of 100 feet.*

No.	Species.	Height.	Girth.	No.	Species.	Height.	Girth.
		Feet.	*Inches.*			*Feet.*	*Inches.*
1	Æsculus glabra	83	35	21	Populus grandidentata	97	57
2	Amelanchier Canadensis	38	28	22	Populus heterophylla	92	90
3	Asimina triloba	48	32				
4	Carpinus Caroliniana	32	54	23	Prunus Americana	28	27
5	Celtis Mississippiensis	95	132	24	Prunus angustifolia	20	21
6	Cercis Canadensis	54	66	25	Ptelea trifoliata	15	12
7	Cornus florida	50	50	26	Pyrus coronaria	38	26
8	Cratægus Crus-galli	32	20	27	Quercus digitata	61	72
9	Cratægus mollis	37	27	28	Quercus lyrata	61	54
10	Cratægus tomentosa	26	21	29	Quercus nigra	65	42
11	Euonymus atropurpureus	20	15	30	Rhus copallina	32½	29
12	Forestiera acuminata	22	18	31	Rhus typhina	35	12
13	Fraxinus sambucifolia	83	56	32	Robinia pseudacacia (cultivated)	95	138
14	Fraxinus viridis	92	60				
15	Gleditsia aquatica	90	57	33	Salix discolor	15	9
16	Ilex decidua	28	37	34	Salix longifolia	70	20
17	Juniperus Virginiana	75	60	35	Salix nigra	95	108
18	Juniperus communis	25	18	36	Sassafras sassafras	95	144
	Morus rubra	68	124	37	Ulmus alata	55	27
19	Negundo Negundo	60	114	38	Ulmus pubescens	83	88
20	Ostrya Virginiana	25	26	39	Viburnum prunifolium	21	11

In the case of a number of the above-named species only one specimen was measured, and it is therefore highly probable that larger individuals occur.

As a result of these additional measurements the last paragraph on page 56 (continued on page 57) of my first paper requires material modification. Compared with the vast number of trees of mature growth which are cut down and destroyed even in a single year, the number of trees from which these measurements were taken is insignificant indeed, and it is quite certain that in not a single instance has

the largest individual of any species of tree growing in the Wabash Valley within the last twenty-five years been measured.

From the meager data that have been gathered, however, we are able to show that the species may be grouped, according to ascertained maximum height, as follows:

(4) *Number of species reaching 100 feet.*

Maximum height attained.	Number of species.	Maximum height attained.	Number of species.
100 feet	42	145 feet	14
105 feet	38	150 feet	13
110 feet	36	155 feet	11
115 feet	34	160 feet	*8
120 feet	27	165 feet	†6
125 feet	24	170 feet	‡4
130 feet	21	175 feet	§3
135 feet	20	180 feet	‖2
140 feet	15	190 feet	¶1

* *Liriodendron tulipifera, Liquidamber Styraciflua, Platanus occidentalis, Hicoria Pecan, Quercus macrocarpa, Q. velutina, Q. coccinea*, and *Populus monilifera.*

† *Liriodendron tulipifera, Platanus occidentalis, Hicoria Pecan, Q. coccinea, Q. macrocarpa*, and *Populus monilifera.*

‡ *Liriodendron tulipifera, Hicoria Pecan, Quercus coccinea*, and *Populus monilifera.*

§ *Liriodendron tulipifera, Hicoria Pecan*, and *Quercus coccinea.*

‖ *Liriodendron tulipifera* and *Quercus coccinea.*

¶ *Liriodendron tulipifera.*

(5) *List of trees of which no measurements have been taken.*

1. *Aralia spinosa.* Angelica Tree; Hercules Club; Devil's Walking-stick.
2. *Hicoria aquatica.* Water Hickory.
3. *Castanea dentata.* American Chestnut.
4. *Castanea pumila.* Chinquapin.
5. *Chamæcyparis thyoides.* White Cedar.
6. *Cratægus coccinea.* Scarlet Hawthorn.
7. *Cratægus cordata.* Washington Hawthorn.
8. *Cratægus spathulata.* Small-fruited Hawthorn.
9. *Magnolia acuminata.* Cucumber Tree.
10. *Pinus echinata.* Yellow Pine.
11. *Pyrus angustifolia.* Narrow-leafed Crab-apple.
12. *Quercus Phellos.* Willow Oak.
13. *Tilia heterophylla.* White Basswood.

In the list of species "usually classed as shrubs," on page 58 of my original paper, those numbered 1, 2, 3, 6, and 7 are to be canceled and transferred to the list of trees. Their measurements are given in table 3 of this paper, on page 419.

In the table which immediately follows the above-mentioned list No. 1 should read *Ilex decidua* instead of "*Ilex verticillata*," and to the species (trees and taller shrubs) whose measurements are there given may be added the following:

(6) *Measurements of larger shrubs.*

No.	Species.	Locality.	Total height.	Girth.
			Feet.	*Inches.*
5	Cephalanthus occidentalis	Mount Carmel, Ill	8	12
6	Cornus paniculata	do	15	8
7	Forestiera acuminata	do	22	18
8	Juniperus communis	Saline County, Ill	25	18
9	Salix sericea	Mount Carmel, Ill	15	11
10	Staphylea trifolia	do	18	11

The specimens from which the above measurements were taken formed part of the fine collection exhibited by the State of Illinois at the New Orleans Exposition.

It may be of interest in this connection to give the following measurements of the larger growing woody climbers, for which also I am indebted to Dr. Schneck:

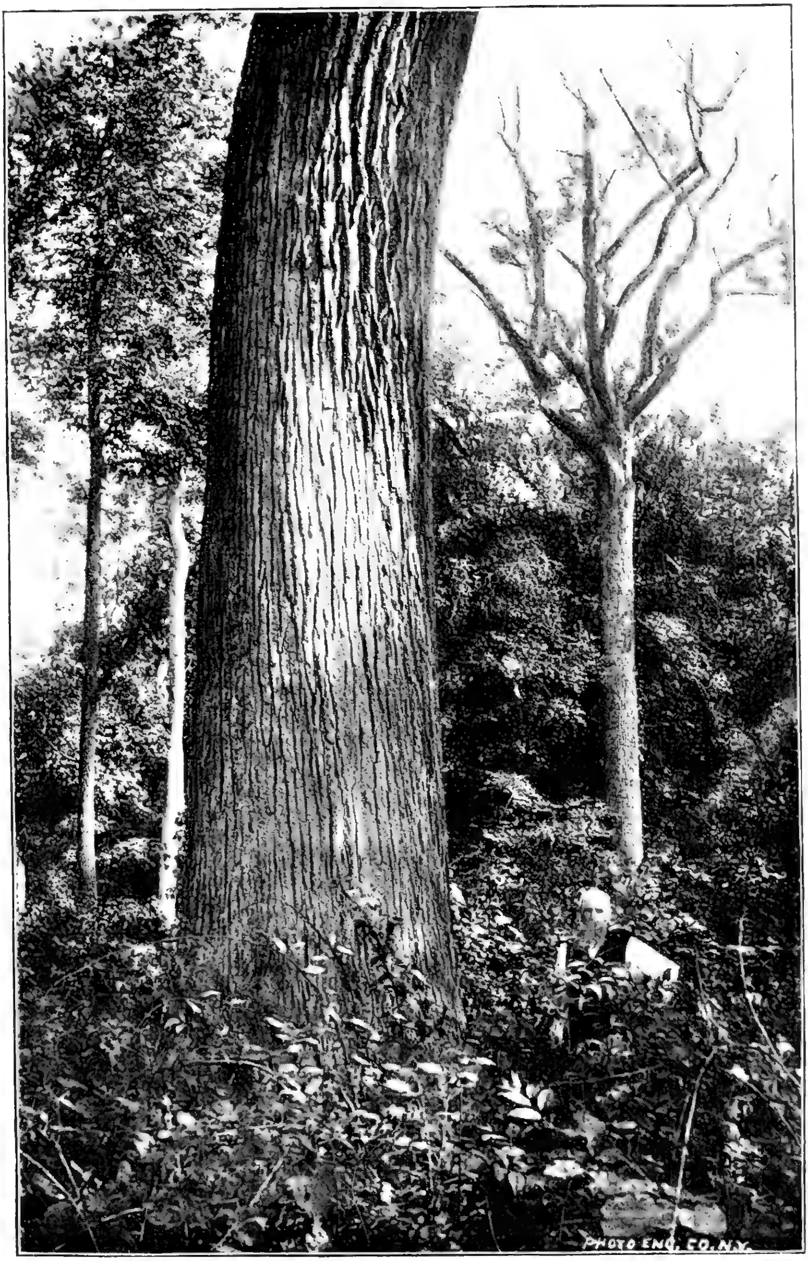
(7) *Measurements of larger woody vines.*

No.	Species.	Total length.	Girth.
		Feet.	*Inches.*
1	Aristolochia tomentosa	83	10
2	Rhus toxicodendron	97	18
3	Tecoma radicans	87	*19
4	Vitis cordifolia	115	†26
5	Vitis riparia	60	12
6	Cissus ampelopsis	50	12
7	Bignonia capreolata	‡(?)	....

* The average circumference of four stems measured by me was 39½ inches, the largest being 41 inches in girth. One of 40 and another of 35 inches girth climbed the same tree.

† The largest vine of this species measured by me was 36 inches in circumference. Four vines of *V. æstivalis* averaged 30¾ inches in girth at 3 feet from the ground, the largest being 38 inches around.

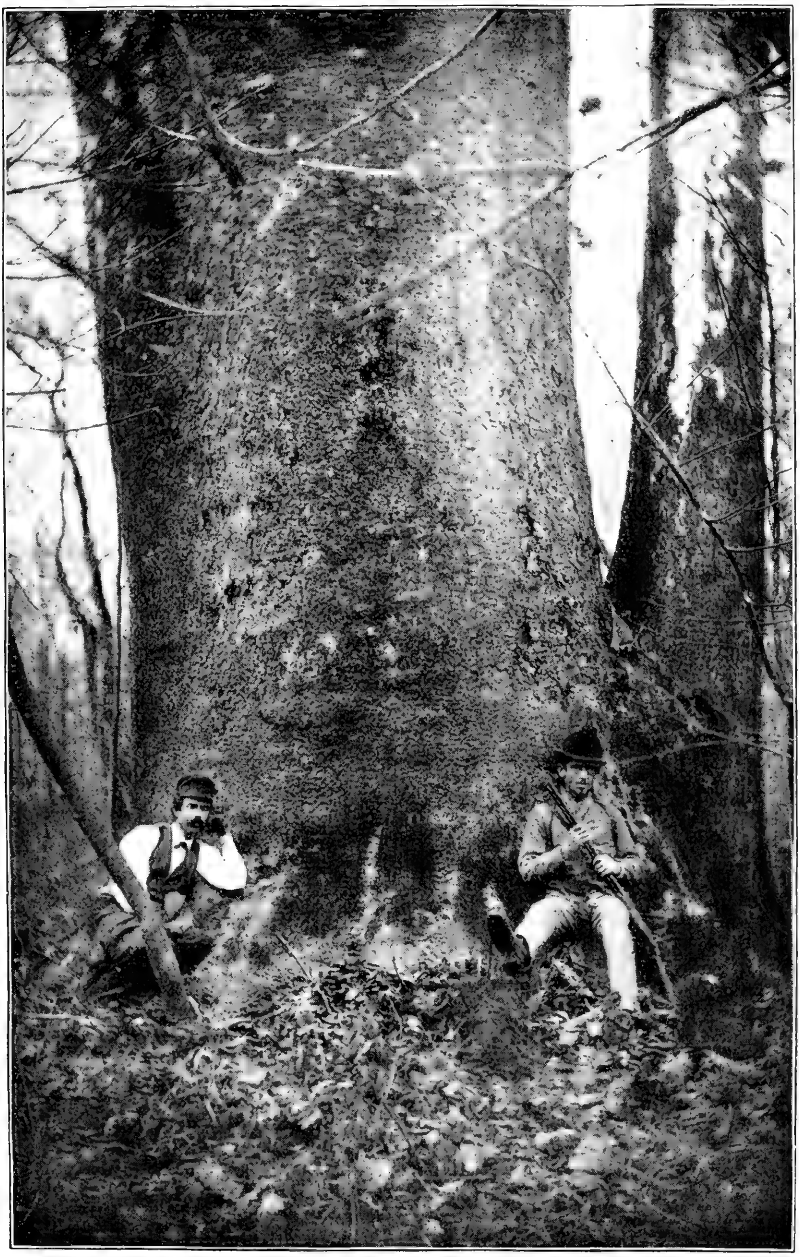
‡ This, though climbing high, is a very slender vine, few stems much exceeding 1 inch in diameter; one which I pulled loose from the trunk of a large tree measured 55 feet to its first ramification.



A Large Tulip Tree.

Liriodendron Tulipifera, Linnæus.

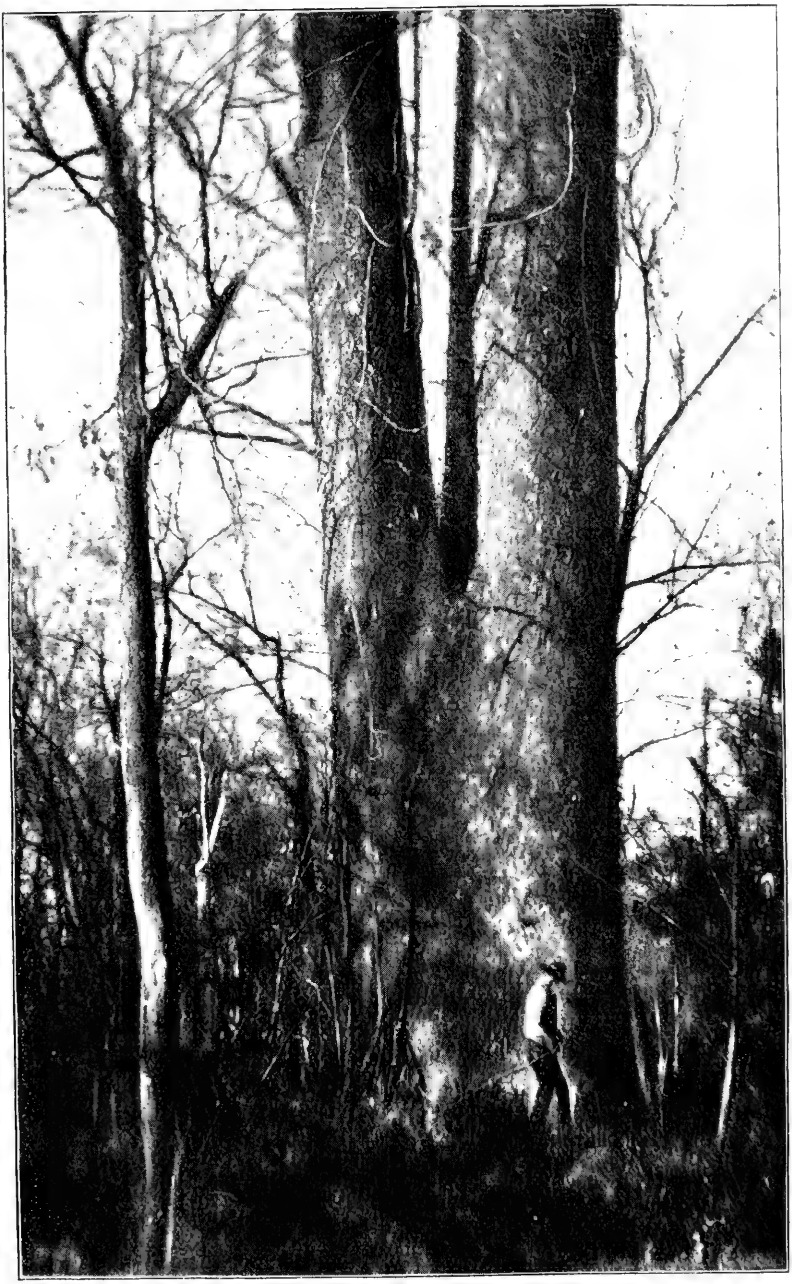
Knox County, Indiana.



A GIANT SYCAMORE.

Platanus occidentalis, Linnæus.

Gibson County, Indiana.



A GIANT SYCAMORE.

Platanus occidentalis, Linnæus.

Gibson County, Indiana.

A TALL SYCAMORE.

Platanus occidentalis, Linnæus.

Richland County, Illinois.

TYPICAL UPLAND FOREST, LOWER WABASH VALLEY.

Knox County, Indiana.

TYPICAL BOTTOM-LAND FOREST, LOWER WABASH VALLEY.

Gibson County, Indiana.

DISTRIBUTION OF THE LAND AND FRESH-WATER MOLLUSKS OF THE WEST INDIAN REGION, AND THEIR EVIDENCE WITH REGARD TO PAST CHANGES OF LAND AND SEA.

By Charles Torrey Simpson.

Aid, Department of Mollusks.

The West Indian archipelago lies almost wholly within the tropics, and extends from latitude 10° to 27° 30′ north, and between longitude 59° and 85° west, and embraces an area of about 95,000 square miles. It presents an example of an astonishingly rich and diversified land snail fauna; in fact no other area of the globe of equal extent can be compared with it. Within this region there are about 1,600 species of terrestrial mollusks, belonging to some 65 genera, a number almost as great as that found on the mainland of the entire continent of America. The structure of the Greater Antilles is very different from that of the lesser archipelago,* or from that of the Bahama group. Each of the four large islands is believed to consist of a nucleus of igneous and metamorphic rock, that forms the summits of the higher mountains, which are flanked by Cretaceous, Tertiary, and Post Tertiary beds. The loftiest peaks of eastern Cuba attain a height of 8,400 feet; those of Haiti and Jamaica a little over 7,000, while Puerto Rico's greatest elevation is slightly less than 4,000 feet. These mountain chains run, for the most part, lengthwise of the islands, and from a glance at the map one can not help thinking that Haiti—which looks something like an enormous letter Y, with one arm pointing toward Cuba, the other in the direction of Jamaica, while the stem is directly in line with Puerto Rico—is a sort of connecting link in the great archipelago. The channel between Cuba and Haiti is 875 fathoms in depth, the one dividing the latter island from Jamaica is about 1,000, while that between Puerto Rico and San Domingo is 260 fathoms deep.

*In the following pages the term Lesser Antilles or Windward Islands will be used to include all the islands south of the Anegada Channel, beginning with Sombrero, Anguilla, and St. Martin, and including Trinidad. The islands lying north of and along the coast of Venezuela will be called the Leeward Group. Cuba, Haiti, Jamaica, Puerto Rico, the Isle of Pines, and the Virgin Islands are included in the general term Greater Antilles.

Between Cuba and Jamaica there is a great trough some 3,000 fathoms in depth, known as the Bartlett Deep. Running nearly due west from Cape Cruz on the south side of Cuba, and north of the profound abyss is a shoal on which are the Cayman Islands, but which deepens to 1,500 fathoms before reaching Belize. To the southwest of Jamaica a wide shoal extends to the coast of Honduras, forming the Mosquito, Baxonuevo, Savanilla, Rosalind, and Pedro banks, along which are scattered low islets, and which, with an elevation of 500 fathoms, would connect Jamaica with the continent. The western end of Cuba points directly toward Cape Catoche, from which it is separated by a strait 130 miles wide and 1,164 fathoms deep. The 100-fathom line would unite Cuba to the Bahamas. At the southeast the Greater Antilles are separated from the Lesser by the Anegada Channel, which carries in a depth of 1,100 fathoms from the Atlantic, ending in a deep basin between Santa Cruz and St. Thomas of 2,400 fathoms. East of this a ridge crosses it which comes within 900 fathoms of the surface.

The Lesser Antilles have not a central nucleus of igneous or metamorphic rock. In referring to this subject Alexander Agassiz says:*

> The position of the most recent Pliocene and Post Pliocene beds seems to indicate that some of the volcanoes now active in the West Indies date back to the Pliocene period, and others to the Post Pliocene. The islands to the north of Guadeloupe form two parallel chains, the western consisting of Saba, St. Eustatius, St. Kitts, Nevis, Redonda, and Montserrat, all of which are volcanoes of Post Pliocene date; while to the eastward is a chain of volcanoes of Tertiary age—Sombrero, Anguilla, St. Martin, St. Bartholemew, Barbuda, and Antigua. At Guadeloupe the recent islands are directly united with the volcanic chain, and the still more recent limestones are found on its western shores.

Agassiz and other authorities agree that the northern portion of the Lesser Antilles is of much more recent origin than the greater archipelago, and the volcanic chain no doubt rests upon a submarine plateau.

The Bahama group is also believed to be of somewhat modern origin. Agassiz thinks that it was formed on an extensive shoal, from the remains of marine animals deposited at a time when the current from the Gulf of Mexico flowed over the area of the present archipelago with very much less velocity than it does at present.† All the islands are low, and many of them are of coral formation.

Before entering into details as to the distribution of genera and species it may be well to say a few words as to the means of dispersal of the land and fresh-water mollusks. Where closely related forms or groups are found in lands separated by the sea, I think we may generally conclude that they have reached their present distribution by one or more of the following means:

First:—By former land connection which hasexisted within the lifetime of present species or groups.

Second:—By the sea, by means of oceanic currents, winds, or storms. It is very well understood now that many land, and some fresh-water

*Three cruises of the Blake, I, p. 109.

†*op. cit.*, p. 75.

plants and animals are carried across more or less wide spaces of ocean from shore to shore in various ways on the surface of the sea. In tropical countries especially, heavy rains swell the mountain streams to torrents, which tear up trees and masses of earth held together with a network of roots, and bear them swiftly to the ocean. These are often peopled with land snails, or carry their eggs, and in their course to the sea may frequently plow up mud from the bottom which contains fresh-water mollusks. Or fresh-water snails may inhabit the surface and crevices of such trees, that become stranded on their way down, or lay their eggs on them, the whole to be carried onward at the next flood. In many places, notably the northern shores of South America, the sea is constantly encroaching on the land, and large areas of forest bound together by matted roots and tangled vines are being undermined and swept away.

Of course if the distance from land to land is short, and there are winds that blow, or tides that run in the right direction, the probability of such mollusks being safely carried across is much greater than if they have far to travel, have head winds, or contrary currents. Darwin has shown that some of the land snails will live for considerable periods of time in sea water, and many of the fresh-water species will remain alive for some time in the air under favorable circumstances, and others are found living in water more or less brackish. One who has noticed much of the drift in the West Indian region—trees and bamboos, often carrying masses of earth and stones—can easily believe that they might bear with them snails for quite a voyage without wetting them to any considerable extent.* I think I shall be able to show that most of such migrations in and about the West Indies have been accomplished under favorable circumstances, that long stretches of unprotected sea, head winds, and contrary currents have generally proven fatal to dispersal by the ocean.

Third:—The agency of man. It is hardly necessary to mention the well-known instances where man is known to have been the means of carrying from one country to another different animals or plants. Many mollusks are known to have been transported through his agency. *Helix similaris* is a native of eastern Asia, but is now naturalized in most of the warmer parts of the world. *Helix aspersa* and *lactea*, common edible snails of Europe, are colonized in a number of foreign coun-

*The hollow stems of dead bamboos are a favorite retreat for many species of terrestrial and arboreal snails. These gigantic tufts of grass are particularly abundant along the streams in tropical countries, and are often washed out in time of floods, and scattered along the banks. Between rainy seasons the upper joints become more or less broken and decayed, and peopled with mollusks, and another freshet sweeps them with their living cargo into the sea. The lower joints, being more solid are perhaps air-tight, and serve to buoy up the whole mass; the roots weighted with earth and stones depress the lower end of the clump, and throw the upper and inhabited end out of water. I have seen just such floating rafts, and nothing could be more admirably contrived for transporting land snails safely across the sea.

tries, as well as *Rumina decollata*, and many others. I have little doubt that *Subulina octona* has been introduced into a number of the West Indian islands in this manner, for C. B. Adams mentions that in 1849 it was found only in a single locality in Jamaica, in a garden near Kingston,* while now one can not pick up a handful of shells anywhere on the island without finding it.

Orthalicus undatus, a Mexican species now found in south Florida, Cuba, Jamaica, and some of the Windward Islands, is another case in point, no doubt.†

Fourth:—By birds. Small mollusks or their eggs may be, and no doubt are, sometimes carried from one locality to another in mud attached to the feet or feathers of birds. And lastly, it is possible that such mollusks or their eggs might be transported moderate distances by windstorms, though such migrations are probably very rare.‡

A number of eminent biologists have regarded the Antillean region as an independent one, and among these are De Candolle, Schouw, Martins, Berghaus, Hinds, Woodward, Baird, Griesbach, Brown, Sclater, Wallace, Engler, Packard, Drude, Hartlaub, and Fischer. These men studied the plants, forests, animals in general, birds, and mollusks. Others, among whom are Agassiz, Heilprin, and Merriam, have regarded it as a subregion of the American tropical province, and still others have united it with the tropical American region. Whether the evidence of the land and fresh water mollusks of the Lesser Antilles goes to prove it a separate province may well be doubted, since it is peopled so largely with South American species and genera, but I believe that the character of this fauna in the Greater Antilles is very distinct from any other, and that the peculiar genera and subgenera of land mollusks have been developed in the localities where they now preponderate.

Bland, whose exhaustive studies of the distribution of the land shells of this region are well known, and whose conclusions are considered authoritative, says:§

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* Contributions to Conchology, III, p. 48.

† Land and fresh-water mollusks may be often carried from one country to another in the cargoes or ballast of vessels. Ampullarias are frequently imported alive into Europe or North America in the crevices of mahogany logs and several African Achatinas have been carried with coffee plants to Mauritius and other islands of the Indian Ocean, where they flourish as vigorously as the native snails. No doubt many species are introduced on plants. It may be well to mention that it is known that the young of some of the Unionidæ attach themselves by hooks to the fins and gills of fishes, where they become encysted, and in this condition may be transported long distances.

‡ Small fresh-water bivalves have been found attached to the legs of flying aquatic insects and they may thus be borne from one body of water to another.

§ On the Geographical Distribution of the Genera and Species of the Land Shells of the West India Islands; with a Catalogue of the Species of each Island. Ann. Lyc. N. Y., VII, p. 335, 1861.

Seeing, moreover, the greater number of both genera and species, absolutely and proportionately in the islands under consideration, it may not unreasonably be suggested that the insular stamp has rather been impressed on the fauna of the continent than the reverse.

Since the time of Bland's studies the discovery of many new species, a better knowledge of their distribution, the great progress made in classification, and in the soundings of the Caribbean, the Gulf of Mexico, and the adjoining parts of the Atlantic, the added knowledge of the currents and winds, as well as the advances made in the study of the geology and paleontology of this general region go to confirm the above statement, and in the direction of proving that the land molluscan fauna of the greater archipelago is largly a peculiar one; that it developed in part in the region it now occupies, and that it has spread, to some extent, to Florida, the Bahamas, Mexico, Central and South America, and the Lesser Antilles, by some of the means I have mentioned above.

Some 28 genera and subordinate groups of land mollusks are confined strictly to the Greater Antilles, and no less than 24 more have here their metropolis, or greatest numerical development of species.

It has been claimed that there has never been land connection between the islands of this archipelago, and that the homogeneousness of its land and fresh water molluscan fauna could be accounted for by supposing that many of the species had been carried from island to island, by storms or currents, or that they had been transported by other means. While no doubt a small proportion of the forms have thus migrated, yet the number of species common to two or more islands is so small, and the distribution of many of the genera and subordinate groups is so peculiar, that I believe we are not justified in explaining the present distribution by such an hypothesis. Cuba, with nearly 700 species of land and fresh-water mollusks, has only 53 not confined to the island; Jamaica, with over 500 species, has 41; Haiti, with 270 species, has only 30; and Puerto Rico, with 130 species, has 34 stragglers to other localities.*

Now, it is very remarkable that while many species of non-operculate land snails are common to the Greater Antilles and the continent, as well as to several of the different Lesser Antillean islands, not a single operculate is known to inhabit both the greater archipelago and the mainland of tropical America. Two species, *Chondropoma dentatum* and *Helicina subglobulosa*, and possibly a third, *Ctenopoma rugulosum*, all Cuban forms, are colonized in the extreme southern end of Florida,

* Haiti—and under this name I include the whole island—has an area of 28,000 square miles, yet only about one-half as many terrestrial and fluviatile mollusks are known to belong to it as are found in Jamaica. With a very diversified surface, an abundance of forest and rainfall, and a large area of limestone, it is probable that when it is fully explored the number of its land and fresh water mollusks will be doubled, and many interesting points of geographical distribution will be brought to light.

and although nearly half the species of land snails of these four larger islands are operculates, not more than 9 or 10 of them are found outside of a single island. This might be taken as evidence that the non-operculate forms were of much more ancient origin than the others, many of them reaching back to a time of former land connection, while the operculate species were of more recent development, which I suspect may be the case; or that the former are better adapted to migration across the ocean than the latter.

The fact that the operculates form so large a proportion of the Antillean land snail fauna, that a majority of the genera are found on two or more of the islands and the mainland, while nearly every species is absolutely restricted to a single island appears to me to be very strong testimony in favor of a former general land connection.

I believe that all the evidence of the terrestrial and fluviatile molluscan fauna of this region indicates that in the early Tertiary Period, perhaps, there was a general land elevation of the Greater Antilles, and possibly of some of the adjacent area; that Wallace's theory of a land connection of the greater islands is correct; that during some part of this time a landway extended across to the continent;* that the species and groups of this then connected territory migrated to some extent from one part of it to another, and that a probable connection existed over the Bahama plateau to what was at that time no doubt the island of Florida. It would appear that at this time the volcanic islands of the Lesser Antillean chain were not yet raised above the sea, or that if there was land in that region it has since been submerged, and there seems to be no good evidence in favor of any land connection with the Greater Antilles since the lifetime of the present groups and species of West Indian land and fresh-water mollusks.

We have not as yet a sufficient knowledge of the geology and palæontology of this general region, or a large enough acquaintance with the distribution of the terrestrial and fluviatile mollusks in Central and South America to at all fully trace the past history of the region, or of the forms of life in question, and, therefore, most of these theories and speculations are advanced with the utmost caution, and rather as suggestions, subject to modification by future discoveries, than as absolute explanations of the facts. Yet enough is known to make many points reasonably certain.

Bland has divided the Greater Antilles into five different sub-provinces: †(1) Cuba, with the Isle of Pines, the Bahamas, and Bermuda;

* It is quite probable that at this time Mexico and most of Central America formed an island; that the sea flowed through what is now the Isthmus of Panama; and that there was connection by a strait from the Gulf of Mexico through or around to the northern end of the Gulf of California. In using the expression "a landway across to the continent" I mean to what is the continent now.

† "Geographical distribution of the West India land shells." Am. Lyc. Nat. Hist. of N. Y., VII., p. 346.

(2) Jamaica; (3) Haiti; (4) Puerto Rico, with Vieque, the Virgin Islands, Sombrero, Anguilla, St. Martin, St. Bartholomew, and St. Croix. The islands south of the latter, to and including Trinidad, he places in a fifth province. Fischer follows essentially this arrangement,* except that he places the Bahamas in a separate division and adds Bermuda to that of North America, though he thinks the latter group of islands shows about equal malacological affinities with Florida and the Antilles.

While the molluscan faunas of each of the four large islands of the Greater Antilles contain much that is peculiar, yet I believe that the relationship of the genera and species is much closer than has generally been supposed. Among genera that are restricted to this archipelago only five are confined to Cuba—*Glandinella*, *Diplopoma*, *Blæsospira*, and *Xenopoma*, each having but a single species, and *Polymita*, with four species; one is restricted to Haiti—*Rolleia*, with one species—and two to Jamaica—*Zaphysema*, with six species, and *Jamaicia*, with two. Of genera of wide distribution that are found only on a single island there are three in Cuba—*Cionella*, *Gundlachia*, and *Vivipara*, each with a single species—and four in Jamaica—*Carychium*, *Strobilops*, *Hemisinus*, and *Valvata*, each with one representative—while Puerto Rico has a single *Clausilia*, and three Peltellas.

Nearly all the peculiar genera, and those of wide distribution that are at all numerously represented, are found in three, if not all four, of the larger islands. The following table exhibits the distribution of all the terrestrial and fluviatile genera. The marine Neritinas, the semi-aquatic Auriculidae, and the Truncatellas, which are distributed in the same way as the ordinary salt-water Gastropods, are not included. There are no peculiar fresh-water molluscan genera in the West Indies. The lists of this paper are as accurate as I can make them. The fact that so many changes have recently been made in the literature and classification, and that no two authors agree as to specific and generic values, make it well nigh impossible to give lists that are correct.

* Manuel de Concholiologie, p. 269.

Distribution of genera of West Indian land and freshwater mollusks.

Genera and groups.	Cuba.	Haiti.	Jamaica.	Puerto Rico.	Elsewhere.
Glandina:					
Glandina		1			Mexico; Central America; a few species in South America and the Lesser Antilles; 1 in Southern Europe.
Oleacina	16			2	
Varicella	2		14		
Melia			9	3	
Volutaxis	1	1			Mexico, 10 species; Guatemala, 1.
Streptostyla	4	2		3	Mexico, 39 species; Central America, 12; Peru, 1.
Hyalinia	4	5	11	5	World-wide.
Selenites	1			3	American Continent.
Thysanophora	16	8	19	9	3 species in Mexico and Southern States
Sagda:					
Sagda			15		
Hyalosagda			4		
Odontosagda	1	2			
Zaphysema			6		
Polymita	4				
Polygyra	2		1		Mexico; southern United States.
Hemitrochus:					
Hemitrochus	11		1		A few in the Bahamas.
Cysticopsis	7	1			
Plagioptycha		8		1	Bahamas.
Dialeuca			6		
Cordya	8	1			
Jeanneretia	5			1	
Cepolis		4		1	1 in Central America; 1 in Peru.
Pleurodonte					Lesser Antilles; northern S. Am.
Pleurodonte			25		
Carocolus	1	5		2	
Thelidomus	10		2	2	2 in Lesser Antilles.
Polydontes	3				
Parthena		5		2	
Luquillia				3	
Eurycratera			1		
Strobilops			1		Mexico; United States.
Bulimulus	3	6	3	7	Tropical America; Lesser Antilles.
Simpulopsis		1		1	Mexico and northern South America.
Liguus	4	1			Florida, 1 species.
Orthalicus	1		1		Mexico to Brazil.
Cylindrella:					
Apoma	6		2		
Thaumasia	1	22	25		
Callonia	2				
Gonglyostoma	91	4	6	2	7 in Mexico; 4 in Guatemala; 3 in northern South America.
Mychostoma	6	5	6		
Strophina		1			
Anoma			8		
Trachelia	24	3		1	
Vendryesia*		2	7		
Macroceramus	34	14	3	3	1 in Guatemala; 3 in Mexico; 1 in Texas; 1 in Honduras; 2 in Florida.
Pineria	2			1	2 in Isle of Pines; 1 in St. Bartholomew; 1 in Guadeloupe.
Pseudobalea	2	1		1	
Peltella				3	Brazil.
Stenogyra	6	1	7	2	Warm regions in general.
Subulina	7	2	14	2	Warm regions.
Opeas	8	4	3	6	Tropical America; a few in East Indies.
Spiraxis	2	2	11	1	17 species on American Continent; a few in Old World.
Glandinella	1				
Melaniella	7				St. Thomas; Bahamas; Florida; Trinidad.
Leptinaria			1	3	South America, 6; Guatemala, 2; Lesser Antilles.
Pupa	2	3	5	1	World-wide.
Vertigo	5		2	1	Do.
Cerion	19	3		2	Bahamas; 1 in Florida; a few in Cayman Islands; 1 in Curacoa.
Geostilbia	1	1	2		
Clausilia				1	Europe; Asia; Peru.
Succinea	11	5	4	3	World-wide.
Vaginula	2	2	2	1	Widely distributed.
Cionella	1				Do.
Carychium			1		Do.
Limnæa	2	1	1	1	Do.
Planorbis	8	6	7	10	Do.
Ancylus	3	2	1	2	Do.

* *Lia* and *Leia* are both preoccupied, and at the suggestion of Mr. T. D. A. Cockerell I gladly bestow on this beautiful genus the name *Vendryesia*, in honor of Mr. Henry Vendryes, of Kingston, Jamaica, who has made a lifelong study of the shells of that island.

Distribution of genera of West Indian land and freshwater mollusks—Continued.

Genera and groups.	Cuba.	Haiti.	Jamaica.	Puerto Rico.	Elsewhere.
Gundlachia	1				Widely distributed.
Physa	2		1	1	Do.
Aplexa	1	1	1	1	Do.
Potamopyrgus	1			1	Do.
Hydrobia	2		2		Do.
Vivipara	1				Do.
Pachycheilus	4		1		American tropics.
Hemisinus			1		Do.
Ampullaria	3		1		Do.
Valvata			1		Widely distributed.
Neritina	4	3	5	2	Warm regions.
Proserpina	2		4		Mexico, 2.
Geomelania †	4	1	21		
Neocyclotus:					
Neocyclotus	1		1		24 species on mainland from Mexico to Venezuela; Lesser Antilles.
Ptychocochlis ‡			32		
Rolleia		1			
Crocidopoma	1	3	1		
Megalomastoma	13	1	3		Guatemala, 1.
Choanopoma	24	19	12	3	2 in Mexico.
Jamaicia			2		
Ctenopoma	30	1	2		1 in Florida; several in Bahamas.
Cistula	15	3	3	3	4 in Central America; 2 in Yucatan; 2 or 3 in South America (?); a few in Lesser Antilles.
Chondropoma	57	19		4	Florida, 1; Equador, 1; Venezuela, 4; Mexico, 2; Central America, 3.
Diplopoma	1				
Licina	1	3			
Tudora	7	5	17		1 in Mexico; 1 or 2 in South America and the Leeward Islands.
Colobostylus	4	5	14		1 in Honduras; 1 in Trinidad.
Blæsospira	1				
Xenopoma	1				
Adamsiella	1		12		2 in Guatemala; 3 in South America (?)
Eutrochatella	21	6	6		1 in Honduras.
Alcadia	9	4	14		A few in the Bahamas.
Helicina	58	23	16	9	World-wide in the tropics.
Lucidella		1	4		
Stoastoma		1	80	1	
Sphærium	1		1	1	World-wide.
Pisidium	2		1		Do.

† The species included in this genus, from Cuba and Haiti, were placed by Pfeiffer in *Truncatella* in a section which he called Montanæ (Mon. Pneum. Viv. Sup. II, p. 3), on account of their habitat in the mountains, away from the sea. Crosse has placed them in the sub-genus *Blandiella* (J. de Conch, XXX., p. 303) and states that, so far as is known, they differ from true Geomelanias only in the absence of a prolongation of the anterior part of the aperture. Some of the latter have this development at the base of the aperture, others at the right margin, and a few are scarcely, if at all, produced. *B. filicosta*, and *lirata* of Cuba are in the National Museum collection, and some specimens of these show this peculiarity to a slight degree, and I should pronounce them both to be Geomelanias on conchological evidence without the slightest hesitation.

‡ *Platystoma* Klein, applied by Fischer and Crosse in a generic sense to this group of peculiar Jamaican forms typified by *Neocyclotus jamaicensis* Chemnitz (Miss. Sci. au Mex. 7th part, p. 149), has been several times preoccupied. Klein was not a binomial author.

The name, therefore, can not stand, and I would substitute that of *Ptychocochlis* in place of it. The group on conchological characters seems to be nearly related to *Neocyclotus* Fischer and Crosse, in which, for the present, I think it had better remain as a subgenus.

It will be seen from the above table that no less than 37 genera are either peculiar to the Greater Antilles or have here their principal developement. These are *Thysanophora*, *Sagda*, *Zaphysema*, *Polymita*, *Hemitrochus*, *Pleurodonte*, *Cepolis*, *Liguus*, *Cylindrella*, *Vendryesia*, *Macroceramus*, *Pineria*, *Glandinella*, *Melaniella*, *Cerion*, *Proserpina*, *Geomelania Neocyclotus*, *Rolleia*, *Crocidopoma*, *Megalomastoma*, *Choanopoma*, *Jamaicia*, *Ctenopoma*, *Cistula*, *Chondropoma*, *Diplopoma*, *Licina*, *Tudora*, *Colobostylus*, *Blæsospira*, *Xenopoma*, *Adamsiella*, *Eutrochatella*, *Alcadia*, *Lucidella*, and *Stoastoma*, and they are represented in this region by

1,023 species. Seven of these genera are found in all four of the larger islands; *Thysanophora*, *Hemitrochus*, *Pleurodonte*, *Cylindrella*, *Macroceramus*, *Choanopoma*, and *Cistula*, with 514 species in this region; while twelve more, *Sagda*, *Cerion*, *Geomelania*, *Megalomastoma*, *Crocidopoma*, *Ctenopoma*, *Chondropoma*, *Tudora*, *Colobostylus*, *Eutrochatella*, *Alcadia*, and *Stoastoma*, represented by 401 species, are found in three or a majority of the islands.

Of the remainder of the Greater Antillean genera nine are found in two islands, *Cepolis*, *Liguus*, *Vendryesia*, *Pineria*, *Proserpina*, *Neocyclotus*, *Licina*, *Adamsiella*, and *Lucidella*, with only 84 species, and 9 are limited to a single island, *Zaphysema*, *Polymita*, *Glandinella*, *Melaniella*, *Rolleia*, *Jamaicia*, *Diplopoma*, *Blæsospira* and *Xenopoma*, with but 24 species.

Of the widely distributed genera whose metropolis is elsewhere, and which we may suppose have entered this region by some of the means I have previously mentioned, 16 are found in all four of the islands, represented by 371 species; 6 are met with in three of the islands, with 33 species; 10 in two of them, with 31 species, while only 7 genera are found limited to a single island, six of them having but 1 species each, and one having 13 species.

From the above figures the remarkably homogeneous character of the terrestrial and fluviatile molluscan fauna of the Greater Antilles may be understood, for out of 78 genera here represented by about 1,400 species, 22, nearly one-third of them, are met with in all four of the islands, having 885 species, or more than 60 per cent of the whole number; and 18 others are common to three of the islands, with 434 species. It will thus be seen that nearly all the important genera have a general distribution in this region, and are largely represented in species.

Now, while it is true that certain genera and minor groups are peculiar in some cases to a single island, as, for example, the typical Pleurodontes, *Zaphysema*, and *Ptychocochlis* to Jamaica, *Polymita*, and *Diplopoma* to Cuba, *Rolleia* to Haiti, or *Luquillia* to Puerto Rico, yet it is no doubt equally true that the relationship between them and certain groups found on other islands of this archipelago is quite close. The toothless or slightly toothed Pleurodontes of Jamaica are not very far removed from *Carocolus*; *Dialeuca*, also a Jamaican group, is very closely allied to the Cordyas of Cuba and Haiti, and Pilsbry has shown* that *Zaphysema*, *Thysanophora*, and *Sagda* are quite intimately related. Such alliances between the species of the different islands are very common, especially among the Helicidæ, *Cylindrella*, *Macroceramus*, the Alcadias, and Helicinas. In short, there can be but little doubt that all or nearly all the special groups confined to one or more of these islands are much more nearly related to other Greater Antillean groups than to those of any other part of the world.

This period of elevation in the West Indies was followed by one of

*Manual of Conchology, second series, IX, p. 60.

subsidence. It continued until only the summits of the mountain chains were above the level of the sea, and probably reached its culmination sometime in the Miocene period. During this time such groups of terrestrial and fluviatile mollusks as then existed were driven higher and higher up the mountain sides, and crowded into ever-narrowing quarters, and it is quite probable that some of the genera and many species were drowned out or perished for want of room and food. As Puerto Rico consists mostly of low, comparatively level land, with a single not very lofty mountain range, it is possible that the limited area left above the sea accounts for the absence of many genera found in the other islands, and which may have been abundant within its borders at the time of a former land connection.

During a visit to Jamaica the past winter the writer, in company with Mr. John B. Henderson, jr., of this city, obtained three large boxes of fossil marl, which we dug from a bed some two feet in thickness, in what is called the White Limestone Series of the Miocene at Bowden, near the east end of the island. This marl, which was brought to the Smithsonian Institution, has proven to be astonishingly rich in fossils, especially marine mollusca, and in it were found six species of land shells, consisting of a *Ptychocochlis*, a *Lucidella*, a *Pleurodonte*, a *Thysanophora*, an *Opeas*, and a *Succinea*. The first two and the last named were in good condition, and nearly perfect; the *Pleurodonte* was represented by two fragments, an apex with three whorls, and an aperture containing the teeth. The *Thysanophora* was in a crumbling condition and the two specimens of *Opeas* were broken. At Bogwalk, at the foot of a Miocene limestone ledge, the writer found fragments of fossil Sagdas, but not in a condition for identification. These shells were no doubt washed down by rains and streams and deposited in the marine strata, as we found in several cases an abundance of recent forms in the bays and thrown up along the shores. I consider the evidence of these fossil land shells with regard to the past history of the groups, and of the Greater Antilles, quite important. They show that in the Miocene period, at a time when perhaps all but the summits of these islands was submerged, several of the great characteristic groups of this region were in existence; that no change whatever has taken place in their characters beyond the differentiation of species; for, with the exception of the *Succinea*, which does not seem to differ from *S. latior*, an abundant species on this land, and the *Opeas* (*O. striata*, also very common) all these forms are probably extinct. The Bowden beds are believed to be the equivalent of the Chattahoochee formation of the southeastern United States, and were no doubt laid down in the earlier part of the older Miocene. The stratum from which these fossils were dug is only a few feet above sea level, and is overlaid with shales and marls to the summit of the hill, some 300 feet above. *Succinea* is world-wide as well as *Opeas*, and neither are distinguished in the West Indies by any special characters. *Thysanophora* is distributed throughout the Greater

Antilles, and has a few representatives on the mainland, the Bahamas, and the Lesser Antilles.

All the species of the subgenus *Ptychocochlis* agree very closely in their corrugated shells and the character of the opercula; and this group, together with the typical Sagdas and Pleurodontes, are confined to the island of Jamaica. It is not unreasonable to suppose that during the period of general elevation certain forms from the widely distributed genera of land and fresh-water mollusks crossed over to the Greater Antilles from the continent, that such genera as *Glandina*, *Streptostyla*, and others whose metropolis is on the mainland also migrated across, and that species of a number of genera whose greatest development is in this archipelago spread out and reached the shores of America. Most of the subordinate groups of *Glandina* and *Streptostyla*, and several of those of *Cylindrella* were then in existence, for we find their species to-day alike on the continent and the different islands of the archipelago. During the subsidence, which must have been gradual, Jamaica was first separated from the rest of the Greater Antilles, and between the time of separation and the date of laying down the Bowden marl it is probable that the typical Pleurodontes and *Ptychocochlis* were developed from some less differentiated, ancestral stock. The separation of Cuba, which occurred sometime after that of Jamaica, gave rise to the special Cuban groups, or no doubt to such of them as are dominant and abundantly represented on the island; while Haiti and Puerto Rico, being longer united, have a much more closely related fauna.

In his catalogue of the terrestrial and fluviatile mollusks of Haiti* Crosse divides the island into four subregions—one on the north, taking in the Sierra de Monte Christi; another south of this, extending from the Mole St. Nicholas through the island to Cape Engaño; a third embracing the southeast peninsula, and the fourth situated between the arms of the Y, and he remarks significantly:

> It is remarkable that the purely geographical considerations on which some authors regard Haiti as a link that formerly united the four islands are confirmed and corroborated by the existence in each of the four regions of a kind of small malacological fauna, independent of species which are scattered throughout the island and which comprise the common fauna.

Every species of *Colobostylus* known on the island, the group *Thaumasia* of the genus *Cylindrella*, and the representatives of *Vendreysia*, *Stoastoma*, and *Lucidella*, all of which have their metropolis in Jamaica, are found in the southwest peninsula, while the great Helices of Cuban groups are met with in the northwestern arm of the island, and the species of the east end show an alliance with the forms of Puerto Rico.

In the Miocene silex beds of Tampa, Florida, there have been found a number of land shells which probably belong to the same fauna as that which existed during that epoch in the Greater Antilles. These consist of six Helices of the section *Plagioptycha*, a group at present

* Jour. de Conch., XXXI, 1891, pp. 195, 197.

confined to Haiti, Puerto Rico, and the Bahamas, a *Cerion*, not differing greatly in appearance from *C. incana*, but wholly destitute of teeth, a *Cylindrella* much like some of the recent Cuban species, and four *Bulimulus*. The Miocene silex beds of Tampa and the Bowden marl are believed by Dr. Dall to be nearly or quite synchronous. These forms, or their ancestors, may have migrated from Cuba across the Bahama plateau and what is now the bed of the Gulf Stream. An elevation of 344 fathoms would join the Bahamas to Florida.

If, then, a land connection existed between the Greater Antilles and Central America during the period of elevation it would not be difficult for species of *Glandina*, *Streptostyla*, *Volutaxis*, *Polygyra*, *Bulimulus*, *Orthalicus*, *Neocyclotus*, *Ampullaria*, *Pachycheilus*, and *Hemisinus*—genera whose metropolis is on the continent—to pass from the latter to the former, or forms of widespread genera to migrate across to the islands. And on such a landway it seems more probable that the species of *Thysanophora*, *Cylindrella*, *Macroceramus*, *Megalomastoma*, *Choanopoma*, *Cistula*, *Chondropoma*, *Tudora*, *Colobostylus*, *Adamsiella*, and *Eutrochatella*, passed over to Mexico and Central America than that they were carried by currents or any of the other agencies I have mentioned.

In the present state of our knowledge it is a little difficult to tell how long the period of subsidence lasted, and we can not determine with certainty how much of the area of the islands was submerged. An elevation of some 3,000 feet above present sea level probably marks the limit in Jamaica, as the stratified Miocene rocks are believed to reach to about that height.

In another part of this paper I have attempted to show something of the close relationship of the molluscan faunas of the different islands of the Greater Antilles. Jamaica, by the evidence of its land snails, stands the most isolated of any of the islands; Cuba is the next most so, while those of Haiti and Puerto Rico are much more nearly related to each other than to those of either of the first two. About 20 genera and minor groups are confined to or have their metropolis in Jamaica; a like number belongs to Cuba, 7 to Haiti, and 1 to Puerto Rico. Of the special Jamaican groups, *Sagda*, *Pleurodonte* restricted, *Geomelania*, *Colobostylus*, *Tudora*, *Ptychocochlis*, *Adamsiella*, *Alcadia*, *Lucidella*, and *Stoastoma* are abundantly represented throughout the island, and highly characteristic, forming the major part of the land-snail fauna. In Cuba, *Liguus*, *Macroceramus*, *Cerion*, *Choanopoma*, *Ctenopoma*, and *Chondropoma* are generally distributed and characteristic; while *Carocolus* and *Parthena* stand in the same relation to the Haitian fauna.

Now, as bearing directly on this subject, it may be mentioned that the strait between Haiti and Jamaica is deeper than that between any of the other islands, being nearly 1,000 fathoms in depth, that between Cuba and Haiti is slightly more shallow, being only about 875 fathoms,

while the one between the latter island and Puerto Rico carries but 260 fathoms. Supposing these islands to have been united at a former time, then during a period of gradual subsidence, Jamaica would be separated sometime before the rest of the Antillian island would be broken up, then Cuba would be isolated, while Haiti and Puerto Rico would remain united for a longer time. The distribution and character of the land-snail faunas of these islands agree exactly with just what would be the result of such a subsidence and separation.

When this region was revisited with a period of elevation—a period which seems to be still in progress—a large area of limestone was uncovered, which, with a warm climate and an abundant rainfall, was soon overspread with forests and cut into innumerable gullies and ravines, furnishing the very best of conditions for the development of forms, and the multiplication of individual land-snails, and the genera and groups which had been huddled together on the reduced peaks of these islands gradually spread out and took possession of the new territory. I regard these facts as the probable explanation of the enormous development of terrestrial molluscan life in the Greater Antilles.

RELATIONS OF THE LAND AND FRESH-WATER MOLLUSCAN FAUNA OF THE GREATER ANTILLES WITH THAT OF MEXICO AND CENTRAL AMERICA.

It is, I believe, acknowledged that the terrestrial and fluviatile molluscan fauna of the Greater Antilles has certain rather intimate relationships with that of the adjoining mainland of Central America and Mexico. The great genus *Glandina*, which at present has its metropolis in the latter region, is represented in the archipelago by a number of species almost equal to that found on the continent. Only a single recent species exists outside of the warmer parts of America—*G. algira* of southern Europe and northern Africa—though the genus is abundantly represented in the Tertiary beds of Europe. Not only is it found in the Greater Antilles, but several of the minor groups are there represented. The section *Oleacina* is mostly Antillean, but has 4 species on the mainland; *Varicella* has 7 on the continent and 21 in the islands; *Melia* has two species in Mexico and 13 in the archipelago, and the section *Glandina*, which is abundantly represented on the mainland, has a single species in Haiti. *Streptostyla*, another Mexican genus, has 9 Antillean species—4 in Cuba, 2 in Haiti, and 3 in Puerto Rico. *Volutaxis*, a third group belonging to the American mainland, has 1 species in Cuba and another in Haiti, and *Orthalicus*, whose metropolis is in the warmer parts of America, has 1 species common to Cuba and Jamaica.

Fischer and Crosse* divide the Stenogyridæ into two subfamilies—

* Miss. Sci. au. Mexique, 7th part, p. 585.

Caecilianellinæ, with *Geostilbia* and *Caecilianella*, and Subulininæ, with *Azeca*, *Ferussacia*, *Loweia*, *Opeas*, *Rumina*, *Stenogyra*, *Pseudobalea*, *Melaniella*, *Spiraxis*, *Leptinaria*, *Subulina*, and *Glessula* as genera. Among these *Opeas*, though represented in the isles of the Indian Ocean, the East Indies, and Polynesia, has its greatest development on the American Continent from Mexico to Venezuela, but it also has several species in the Greater Antilles; while *Spiraxis*, another genus of this family, mostly American, is about equally represented in this archipelago and on the continent. The genus *Leptinaria*, as defined by Fischer and Crosse, is confined to America, and includes all the species of the Antilles hitherto placed in *Tornatellina*, the latter being by them restricted to the Old World. The former is about equally represented in middle America and the Greater Antilles. *Simpulopsis* is another genus with its metropolis in America, and with a distribution much like *Leptinaria*. To these may be added the continental *Bulimulus*, with 74 species in Central America and Mexico, which is well represented in Cuba, Haiti, Puerto Rico, and Jamaica, and *Polygyra* (restricted), with its metropolis in Mexico and the southern United States, but which inhabits Cuba and Jamaica.

On the other hand, we find that the peculiar terrestrial molluscan fauna of this archipelago has, as Bland has expressed it, "made a strong impression" on the mainland. The following table will show the continental distribution of these Antillean genera:

Distribution of genera of Antillean land mollusks.

Genus or group.	Species in Greater Antilles.	Species of Mexico.	Species of Central America.	Species found elsewhere.
Thysanophora	52	3?		2 in Southern States.
Cepolis	5		1	1 in Peru.
Hemitrochus	12	1?		Several in the Bahamas.
Macroceramus	54	3		2 or 3 in Lesser Antilles.
Cylindrilla	168	7	4	3 in northern S. Am. and Lesser Ant.
Proserpina	6	2		
Neocyclotus	34	2	2?	Northern South America. 20 sp.
Megalomastoma	17		1	
Choanopoma	58	2		
Tudora	29	1		1 or 2 in South America; Leeward Islands.
Chondropoma	80	2	3	South America, 4.
Colobostylus	23		1	1 in Trinidad.
Cistula	24	2	4	2 in South America(?); a few in Lesser Antilles.
Adamsiella	13		2	3 in South America(?).
Eutrochatella*	33		1	

*Several other species of *Pneumonopomata* are found in Mexico, Central and South America, which have been referred to *Adamsiella*, *Cistula*, *Tudora*, and *Chondropoma*, which doubtfully belong to these genera.

Among the fluviatile mollusks there are no genera common to the two regions whose metropolis is in either of them, save *Pachycheilus* and *Hemisinus;* but quite a number of species inhabit both the mainland and the archipelago. The same is true of a good many terrestrial forms. The following list gives these species and their distribution:

Land and fresh-water mollusks i abiting the Greater Antilles and the continent.

Species.	Cuba.	Haiti.	Jamaica.	Puerto Rico.	Mexico.	Central America.	South America.	Elsewhere.
Thysanophora incrustata, Poey.	×				×			Texas; Florida.
Thysanophora plagioptycha, Sh.				×	× ?			Vieque.
Thysanophora dioscoricola, Ad.			×	×	× ?			Vieque; Florida.
Zonites indentatus, Say		×		×	× ?			United States.
minuscula, Binn	×		×	×	×			United States; Bermuda.
gundlachi, Pfr	×	×	×			×		Florida; St. Thomas.
arboreus, Say	×				×			United States; Guadelupe.
Bulimulus liliaceus, Fer		×		×	×	×		St. Kitts.
Macroceramus gossei, Pfr	×		×		×			Texas; Florida.
pontificus, Gld	×				×			Florida.
Pupa contracta, Say			×		× ?			Texas; United States.
pellucida, Pfr	×		×	×	×			Texas; Florida; Vieque; St. Thomas; St. John.
Vertigo ovata, Say	×				×			United States.
Orthalicus undatus, Brug	×		×		×	×	×	Trinidad.
Subulina octona, Ch	×	×	×	×	×	×	×	Lesser Antilles.
Spiraxis subula, Pfr	×		×	×	×			Mobile; Florida; Martinique; St. Thomas; Cochin China.
Opeas caracasensis, Reeve		×			×	×	×	Grenada; Trinidad; Lesser Antilles.
Limnæa cubensis, Pfr	×		×	×	×	×		St. Croix; United States, as *L. umbilicata*, Adams.
Planorbis caribæus, Orb	×			×	×			
tumidus, Pfr	×			×	×	×		Texas; Florida.
havanensis, Pfr	×				×	×		Bahamas.
Potamopyrgus coronata, Pfr.	×		×		×	×		Guadelupe.
Neritina reclivata, Say	×				×	×		Texas; Florida.
punctulata, Lam	×		×		×	×		
Carychium exile H. C., Lea			×		× ?			United States.
* Pisidium abditum, Hald	×				×	×		Do.
Sphærium cubense, Pme	×				× ?			Texas; Florida.
Unio scamnatus, More	×					×		
gundlachi, Dkr	×					×		

*This species is distributed over nearly all the United States and as far south as Honduras: Prime states (American Corbiculidæ, p. 76), that *P. consanguineum*, Prime, of Cuba can scarcely be separated from *P. abditum* Hald., and on carefully comparing authentic specimens in the National Museum I believe them to be the same.

I am not prepared to believe that so extensive a relationship—the exchange of so many genera, subordinate groups, and species—could have been brought about merely by ocean currents and winds. Since the gulf stream was turned into its present course—probably during the later miocene, when the Isthmus of Panama was elevated—its tendency would be to sweep any species that might fall into it, from the Antilles or the continent, up into the Gulf of Mexico, and away from either shore. The prevailing winds of the region have no doubt been from the east-north-east in the past, as in the present, and would favor the landing of Antillean species in Yucatan, though their effect would be largely neutralized by the current. We find that very nearly as great a migration has taken place from the mainland to the archipelago as in an opposite direction. The depth of the Yucatan Channel would seem to preclude the likelihood of a former landway running west from Cuba, but the presence of *Streptostyla*, with eight species scattered through Cuba, Haiti, and Puerto Rico, and *Volutaxis* with two

species, one each in Cuba and Haiti, while neither of the genera are found in Jamaica, appears to favor a more northern as well as a southern landway.

RELATIONS OF THE GREATER ANTILLEAN LAND SNAIL FAUNA WITH THAT OF THE BAHAMAS.

I next pass to the relationship of the land snail fauna of the Greater Antilles with that of the Bahamas. On this extensive archipelago, with some 3,000 islands and an area of nearly 6,000 square miles, there are only about 80 species of land snails known. The climate of the islands is warm, the structure of most of them is coral limestone, and there is a plentiful rainfall, with sufficient vegetation to furnish shelter and food for an abundance of snail life; in fact the number of individuals is in many cases great. All the groups with the exception of the Mexican genus *Schasicheilus*, represented by a single species, are Cuban and Haitien, or are such as are found in those islands; and a number of the species are common to the Greater Antilles. In many genera, especially *Hemitrochus* and *Cerion*, there is an almost endless amount of variation, with few breaks sufficient for the proper separation of species. The islands of the Little and Great Bahama Banks being nearest to Cuba, and lying in the course of the currents that flow by that island, partake most largely of its fauna, while those to the north of Haiti bear more strongly the impress of its forms. Yet when we come to carefully consider the manner in which this archipelago must have been colonized with land snails, we need not be surprised at its comparative poverty of species, or that it has no peculiar genera. Whether in time past this area arose above the sea and had land connection with Cuba and Florida does not matter so far as its present terrestrial molluscan fauna is concerned. As the highest point in the archipelago is only about 300 feet above sea level it is quite probable that the entire Bahaman region was submerged during the general period of subsidence, and whatever species may have existed were doubtless destroyed. We may suppose that during the period of elevation which followed, as soon as these islands began to appear above the sea, and were fitted for the abode of land snails, those nearest to Cuba, Haiti, and the gulf stream received occasional stragglers which drifted across the not very wide channel.*

*The north-east trade winds, and the drift of the water of the Atlantic to the westward, force a strong current along between Haiti and the small, southernmost islands of the Bahamas. Part of this is carried through the windward passage between Haiti and Cuba into the Caribbean, the rest is pressed on past Great Inagua, and up the old Bahama Channel, and finally it mingles with the gulf stream. No doubt part of the water of that great ocean river, crowded in between Cuba, the Bahama Bank, and Florida, spreads out more or less to the eastward among the islands. Thus land snails washed into the sea on the north side of Cuba or Haiti would probably in some cases be carried out and landed among the Bahamas.

This migration by currents and in some cases, no doubt, by winds from the Greater Antilles to the Bahamas, has not been of long continuation, for the reason that the last elevation of this latter archipelago above the sea has been comparatively a recent one and therefore there has not been time for the formation of new genera or subordinate groups, and only for few valid species. Many of the forms are so slightly differentiated that they can not be separated with any degree of accuracy, and others have broken into endless variations, which may be taken as an indication that the region has not been very long colonized and that species are multiplying.

Had this land been connected with Cuba or Haiti since it was last elevated above the sea it is probable that it would now be far richer in genera and species than it is.

THE TROPICAL LAND AND FRESH-WATER MOLLUSCAN FAUNA OF SOUTHERN FLORIDA, AND ITS RELATION TO THAT OF THE GREATER ANTILLES, MEXICO, CENTRAL AND SOUTH AMERICA.

In southern Florida some 28 or more species of land and freshwater mollusks occur, nearly all of which are now living in Cuba, while a few belong in Mexico, 1 possibly in South America, 2 are found in the Bahamas, and 1 perhaps came from Trinidad.*

This terrestrial and fluviatile population of southern Florida is in all probability the result of recent migration, mostly by means of winds and currents. Most of the species are confined to the lower chain of keys or the extreme southern part of the peninsula. *Chondropoma dentatum* extends a short distance north of Cape Sable, *Bulimulus multilineatus* reaches Caximbas, and *Liguus fasciatus* has been doubtfully reported as far north as the Caloosahatchee River. *Guppya gundlachi* and the two *Macroceramus* no doubt extend their range to at least the middle of the State. *Bulimulus dormani*, *Polygyra cereolus*, *Planorbis tumidus*, and *Sphærium cubense* probably inhabit the entire peninsula, and *Ampullaria depressa*, which is a form of *A. caliginosa*, extends into Georgia.

*The following is a list of the species: *Thysanophora cæca*, Gup., Trinidad; *Thysanophora vortex*, Pfr., Cuba, Haiti, Puerto Rico, St. Croix, St. Thomas, Bermuda; *Thysanophora dioscoricola*, C. B. Adams, Jamaica, Puerto Rico, Mexico, Vieque; *Strobilops hubbardi*, Brown, Jamaica; *Hemitrochus varians*, Mke., Bahamas; *Polygyra cereolus*, Muhl, Bahamas, Bermuda, Cuba?; *Guppya gundlachi*, Pfr., Cuba, Puerto Rico, St. Thomas; *Orthalicus undatus*, Brug., Mexico, Jamaica, Trinidad, Central America; *Orthalicus melanocheilus*, Val., Mexico; *Liguus fasciatus*, Mull., Cuba; *Melaniella gracillima*, Pfr., Cuba, St. Thomas, Bahamas; *Subulina octonoides*, Orb., Cuba, Jamaica, Puerto Rico, Vieque, St. John, Barbados, Grenada, St. Thomas; *Spiraxis subula*, Pfr., Jamaica, Cuba, Barbados, Antigua, Puerto Rico, St. John, St. Thomas; *Macroceramus gossei*, Pfr., Cuba, Jamaica, Texas, Mexico; *Macroceramus pontificus*, Gld., Cuba, Mexico; *Bulimulus marielinus*, Poey, Cuba; *Bulimulus dormani*, W. G. B., New Grenada?; *Bulimulus multilineatus*, Say, Yucatan, Guatemala, northern South America; *Cylindrella poeyana*, Orb., Cuba; *Cylindrella jejuna*, Gld., Cuba; *Cerion incana*, Binn., Cuba; *Helicina subglobulosa*, Poey, Cuba; *Chondropoma dentatum*, Say, Cuba; *Ctenopoma rugulosum*, Pfr.?, Cuba; *Planorbis tumidus*, Pfr., Cuba, Mexico, California; *Ampullaria caliginosa*, Rve., Mexico; *Gundlachia ancyliformis*, Pfr., Cuba; *Sphærium cubense*, More., Cuba; Mexico, Texas.

It scarcely seems necessary to enter into any argument to show that these tropical forms now found in Florida are not the lineal descendants of the Helices and *Bulimulus*, the *Cylindrella* and *Cerion* or other species of the Miocene silex beds of Tampa. The living land and freshwater mollusks of Florida of tropical origin are absolutely identical with forms at present found in Cuba, Jamaica, and the continent, while those of the Tampa beds are all extinct, and we can not for a moment suppose that their descendants would be specifically identical with Antillean and Mexican forms that had come from another line of descent. I believe that the present species have been colonized but a short time in Florida, and the fact that, although the soil, contour, and climate of the country are quite different from those of tropical America, not a single introduced form has as yet changed specifically, and only one possibly varietally, is strong evidence in this direction.

It is most likely that tropical land snails have been cast on the shores of the peninsula with the jetsam and flotsam of the sea ever since the Gulf Stream has had its present course, an amply sufficient length of time for the development of species from some of the original wanderers, as that great ocean river was probably turned into the Gulf of Mexico and past the State of Florida during the latter part of the Miocene, when the Isthmus of Panama is believed to have been raised and North and South America were joined together. I would suggest that the reason why no such new species exist there might be that in all probability any forms that were colonized on the peninsula prior to the time of the Glacial Epoch were destroyed by the change of climate, which swept out of existence, and drove to the southward so much of the animal and vegetable life of North America.* The presence of a great cap of ice coming down to the latitude of 40°, within 10° or 600 miles of the northern part of the State, would, especially at certain times in winter during the prevalence of northerly winds, be likely to destroy by cold such species as might be landed by the Gulf Stream. Even now, with a much milder climate than this region possessed during Glacial times, an occasional unusually severe winter almost annihilates the tropical fishes of this region, and kills in part, or even entirely, many forms of West Indian vegetation as far south as Cape Sable. Several of these Cuban land snails are only met with on the lower keys, an area practically free from frost.

We know that a very slight difference in latitude or climate may often set a bound on the distribution of different forms of animal and vegetable life. Thus, nearly all the immigrant West Indian vegetation now found in Florida is confined to the southern half of the peninsula, though there are no apparent reasons so far as soil, food, and moisture

* It may be claimed that the continual addition of fresh individuals from Cuba by the currents has kept the species already landed in Florida from becoming specifically changed. But the same addition of fresh specimens must have occurred in the Bahamas and yet we there find a number of new species and countless varieties.

are concerned why it should not extend north indefinitely. The tropical land snails of Mexico come north in the low lands for the most part only to the northern border of that Republic, and many other instances of a like restriction by climate could be given. It is probable that a decrease of a very few degrees in temperature would destroy the Antillean land and fresh-water mollusks in Florida.

It is believed by many of our ablest glacialists that the Ice Age lasted down to within from 6,000 to 10,000 years of the present, and the period which has elapsed since its close would probably be too short to allow for any considerable variation in mollusks. The Bahamas being protected on the north and west by the Gulf Stream, and lying generally in a lower latitude, no doubt enjoyed during the Glacial Epoch a milder climate than Florida, and have been peopled longer with immigrant forms; a sufficient time to allow for the development of numerous varieties and species, but no groups or genera.

I think there need be no difficulty in accounting for the presence of tropical land and fresh-water mollusks in Florida by means of the transporting agency of the sea. The Gulf Stream sweeps up past northern South and Central America, part of it eddying around in the Gulf of Mexico. A branch of it, however, flows along the north shore of Cuba, and by the shoal in latitude 24° is thrown in close to the lower chain of Florida Keys. Alexander Agassiz says:*

> The curve of the Florida reef along the Gulf Stream is due in great measure, as Hunt shows, to a counter current along the reef running westward. This current is known to all navigators, and though ill defined at Cape Florida becomes stronger and wider as it goes west. It has a width of at least 10 miles at Key West and 20 miles at Tortugas. This is clearly shown by the mass of surface animals driven along upon this westerly current by the southeasterly winds. The tides set strongly across the reefs and through the channels between the keys, the flood running north and the ebb south.

Mollusks washed down with trees, bamboos, or masses of drift from the northern shore of Cuba would be swept along by the strong current of the Gulf Stream to the eastward and northward, and many of them, carried by the southeast winds into this counter current, might be landed by the inflowing tide among the lower keys within a few days after leaving their native island. Species from Honduras might at long intervals be drifted by westerly winds across to the eastern part of the Gulf Stream, and so be carried around and landed in the way I have described; or they might possibly sometimes survive a passage around the eddy in the gulf. The fact that there are more forms from Cuba found in Florida than there are from Middle America, and that only a single very doubtful South American species is known in that state,† illustrates the comparative difficulty which these wanderers

*Three cruises of the Blake, I, p. 57.

†*Bulimulus dormani*, W. G. Binney, is thought to be the same as *B. maculatus*, Lea of Cartagena, Colombia, but this is not certain. *B. multilineatus*, Say, formerly believed to be an immigrant from South America, is now known to be found in Central America and Yucatan.

experience in being drifted to our shores. I may mention in passing that every strictly Cuban species—I think without exception—now known to be living in Florida is an inhabitant of the western end of the island, and most of them are known to have a general distribution throughout the western part of it, and especially on its northern shore.

RELATIONS OF THE TERRESTRIAL AND FLUVIATILE MOLLUSCAN FAUNAS OF THE GREATER ANTILLES AND THE WINDWARD ISLANDS.

A careful examination of the lists of genera, subordinate groups, and species of these two areas will reveal the fact that while there is a relationship between the two faunas it is not nearly so close as the one between the faunas of the former region and the continent.

Land Snails common to Puerto Rico and the Lesser Antilles.

Species.	St. Kitts.	Barbuda.	Antigua.	Guadeloupe.	Dominica.	Martinique.	St. Lucia.	St. Vincent.	Barbados.	Tobago.	Grenada.	Trinidad.
Vaginula occidentalis, Guild	...	...	...	×	...	×	...	×	...	...	...	...
Thysanophora vortex, Pfr	...	...	...	...	...	...	...	...	×	...	...	...
Bulimulus lilacinus, Fer	×	...	...	...	...	...	...	...	...	...	...	...
fraterculus, Fer	×	...	...	×	...	...	...	...	...	...	...	...
virgulatus, Fer.*	...	...	...	...	...	...	...	...	...	...	...	...
exilis, Gm. †	...	×	...	×	×	...	...	...	×	...	...	...
Pineria viequensis, Pfr	...	...	...	...	...	...	...	...	...	...	...	×
Opeas subula, Pfr. ‡	...	...	×	...	...	...	...	...	×	...	×	...
goodalli, Mill	...	...	...	×	...	...	...	...	×	...	...	...
Subulina octona, Chem	...	...	×	×	...	...	...	...	×	...	...	×
octonoides, C. B. A	...	...	...	...	...	...	...	...	...	...	×	...
Leptinaria antillarum, Shutt	...	...	...	×	...	...	...	...	×	...	...	...
Pupa pellucida, Pfr	...	...	...	...	...	...	...	...	×	...	...	...
Succinea approximans, Shutt	...	...	...	...	...	...	...	...	...	...	...	...

* Also found in the island of Buen Ayre, of the Leeward Group.
† French Guiana also.
‡ Several of these Stenogyridæ and some other species have probably been introduced through the agency of man.

Fresh-water Mollusks common to Puerto Rico and the Lesser Antilles.

Species.	Guadeloupe.	Martinique.	Dominica.
Planorbis guadaloupensis, Sowb	×	×	...
schrammi, Crosse	×	...	...
lucidus, Pfr	×	...	...
Ancylus beani, Bourg	×	...	...
Aplecta sowerbyana, A. d'Orb	×	...	...
Potamopyrgus coronata, Pfr	...	...	×

From the above lists it will be seen that there are 14 species of terrestrial and 6 fluviatile mollusks common to Puerto Rico and one or more islands of the Lesser Antilles, while no less than 24 land mollusks belong to that island and some of the other Greater Antilles, and 13 fresh-water species. The following tables show the specific relationship between these molluscan faunas of Puerto Rico and the other islands

of the more northern group; all of them being found in the last-named island:*

Land Mollusks common to Puerto Rico and other Greater Antillean Islands.

Species.	Cuba.	Haiti.	Jamaica.	Elsewhere.
Vaginula occidentalis, Guild	×	×	....	Guadelupe; Martinique; St. Vincent.
Zonites gundlachi, Pfr	×	×	×	Florida.
minusculus, Binn	×	....	×	United States; Mexico.
Glandina terebræformis, Shutt	....	×	....	
Thysanophora vortex, Pfr	×	×	....	Florida; Barbados.
dioscoricola, C. B. Adams.	....	....	×	Florida.
euclasta, Shutt	×	....	....	
Pleurodonte marginata, Gmel	×	×	....	
Bulimulus nitidulus, Pfr	×	×	×	
liliaceus, Fer	....	×	....	
exilis, Gmel	....	×	....	
Pseudobalea dominguensis, Pfr	×	×	....	
Cylindrella pallida, Guild	....	....	×	
Opeas subula, Pfr	×	×	×	Lesser Antilles; Florida.
goodalli, Mill	×	....	×	Lesser Antilles.
Subulina octona, Chan	×	×	×	Mainland; Lesser Antilles.
octonoides, C. B. Adams	×	×	×	Florida; Mexico; Lesser Antilles.
Spiraxis paludinoides, d'Orb	×	....	×	
Stenogyra terebraster, Lam	×	....	....	
Pupa pellucida, Pfr	×	×	×	Texas; Mexico; Florida; Lesser Antilles.
hexodon, C. B. Adams	....	....	×	
Cerion striatella, Fer	×	×	....	
microstoma, Pfr	×	×	....	
Succinea riisii, Pfr	....	×	....	
Helicina phasianella, Sowb	....	×	....	

Fresh-water mollusks common to Puerto Rico and other of the Greater Antilles.

Limnæa cubensis, Pfr	×	....	....	
Planorbis guadelupensis, Sowb	×	....	....	Mexico; Guadelupe.
tumidus, Pfr	×	....	....	Mexico; Texas; Florida.
riisii, Dkr	....	....	×	
refulgens, Dkr	....	×	×	
haldemani, C. B. Adams	....	....	×	
lucidus, Pfr	....	....	×	Guadelupe.
macnabianus, C.B.Adams	....	....	×	
circumlineatus, Shutt	....	×	....	St. Thomas.
albicans, Pfr	×	....	....	Do.
Ancylus obscurus, Hald	....	....	×	St. Thomas; United States.
Aplecta sowerbyana, d'Orb	×	....	×	St. Thomas; Guadelupe.
Potamopyrgus coronata, Pfr	....	....	×	Guadelupe; Martinique; Central America; Mexico.

It will be seen that so far as species are concerned the relationship between the land and fresh-water mollusks of Puerto Rico is much closer with the Greater than with the Lesser Antilles. It is, however, among the genera and minor groups that the break in the molluscan faunas of the two archipelagoes is most noticable. Among the Helices the genus *Pleurodonte*,† which includes all the sections of the old and well known *Carocolus*, is distributed throughout the West Indies, northern South America, and Central America. The section *Carocolus*, consisting of lenticular toothless species, is confined to the Northern Archipelago, and is found in Cuba, Haiti, and Puerto Rico. The section

* *Helix nemoralina* is common to Haiti, St. Thomas, St. John, Tortola, and the Virgin Islands, but is not found in Puerto Rico.

† I follow essentially Pilsbry's arrangement of the West Indian Helices, in IX., series 2, pp. 54 and 84, and V., p. 5, Manual of Conchology.

Pleurodonte, better known as *Lucerna*, is limited to Jamaica, as is *Eurycratera*. The section *Polydontes* is Cuban; *Parthena* and *Luquillia* are confined to Haiti and Puerto Rico, while *Gonostomopsis*, with a single species, belongs in Martinique, and *Caprinus*, better known as *Dentellaria*, is a characteristic group of the Lesser Antilles, extending into South America, but is not found in the Greater Antilles. *Thelidomus* with a metropolis in the Greater Antilles has three species in the Lesser Antilles and South America. Not a species of the genus *Pleurodonte* is common to the two regions.

Another great genus found abundantly in all the islands of the Northwestern Archipelago, *Hemitrochus*, is absolutely wanting in the Windward Islands, as are also the smaller Cuban genus *Polymita*, the Jamaican genera *Sagda*, *Lucidella*, and *Neocyclotus*, and *Cepolis* of Haiti and Puerto Rico; though the latter genus has a single species in Central America, and another in Peru.

Macroceramus,* *Liguus*, *Cerion*,† *Vendreysia*, *Geomelania*, *Proserpina*, *Ctenopoma*, *Adamsiella*, *Megalomastoma*, *Colobostylus*, *Alcadia*, *Stoastoma*, and *Eutrochatella*, Greater Antillean genera, are entirely wanting in the Lesser group; while *Cylindrella*, *Glandina*, *Cistula*, *Choanopoma*, *Chondropoma*, and *Tudora*, all highly characteristic of the Northwestern Archipelago are but feebly represented by a few stragglers, mostly in the northern end of the chain. Three genera only are peculiar to the Windward Islands; two with a single species each; *Rhodonyx* in Martinique; *Amphibulima* in Dominica, Guadeloupe, and St. Kitts; and *Pellicula* with two species in Guadeloupe.

The fact of the rather recent formation of these northern volcanic islands, built upon an old submarine plateau, that of the comparative poverty of the species and genera of this archipelago, and of their slight relationship to those of the northwestern group, all go to indicate that the Anegada Channel has not in the lifetime of the present land-snail fauna been bridged. A few species, however, have passed, no doubt by way of the sea or other means, from one group to the other, more from the northern islands to the southern than the reverse, as might be expected from the comparatively richer fauna of the former. The current which flows from the Atlantic through this channel would not probably favor the drifting of species from either archipelago to the other, and this with the prevailing wind from the east-northeast would naturally carry most of the land snails washed into the sea out into the open water of the Caribbean, where they would perish.

I do not think that anyone who at all carefully studies the land and fresh-water molluscan fauna of the Lesser Antilles can doubt that it is

* One species *M. signatus* is found in Anguilla. This island and St. Bartholomew having each only a few species, though south of the Anegada Channel, have a somewhat mixed land-snail fauna, partaking of the characters of those of both the Greater and Lesser Antilles. That a few species might have drifted to these islands from the abundantly stocked Northern Archipelago is not strange. Bland groups the two with Puerto Rico.

†One species is found in Curaçoa, one of the Leeward Islands.

for the most part derived from South America. At Trinidad—which is merely a detached fragment of Venezuela—more than half the species are common to the mainland, and among them are one or more of the continental *Borus*, an *Ampullaria*, a *Marisa*, and an *Anodon.**

Borus is found in St. Vincent, Barbados, Guadeloupe, St. Kitts, and Montserrat,† and *Bulimulus*, another most characteristic South American genus is abundant throughout the Lesser Antilles. The 500-fathom line will be found to divide the Lesser Antilles into three groups; the most northern embracing every island from Sombrero and the Saba bank south to and including Dominica. Between the latter and Martinique is a channel 575 fathoms in depth, and south of it is another of 548 fathoms. Beginning with St. Lucia, which is separated from St. Vincent by a depth of 486 fathoms, all the islands to the southward are united to the mainland by the 500-fathom line. Barbados is somewhat isolated, and is surrounded by comparatively deep water, being separated from the chain by 1,403 fathoms, while Trinidad, Tobago, Margarita, and Tortuga are all within the 100-fathom line. Several South American *Bulimus* typified by *B. auris-sileni* are found in the islands from St. Vincent southward, and Martinique, which is separated from the islands north and south of it by channels over 500 fathoms in depth, has no *Pineria*, *Chondropoma*, *Choanopoma*, or *Cistula*, which are Greater Antillean genera found in the Windward Islands north of it. As a proof of the comparative poverty of the Lesser Antilles it may be stated that the whole archipelago does not contain 300 species of terrestial and fluviatile mollusks; scarcely more than half the number belonging to Jamaica.

One group is found in nearly all the Windward Islands, *Caprinus* (better known as *Dentellaria*), a section of the genus *Pleurodonte*, which seems to bear about equal relationship to the sections found in the Greater Antilles, and to *Labyrinthus* of northern South America. There is another division of the genus, *Isomeria*, which is confined for the most part to the higher Andean regions of Peru, Equador, and Colombia, characterized by a lesser development of teeth in the aperture than *Labyrinthus*, and which may have sprung from the latter. The distribution of these groups is a little peculiar. We may suppose the Greater Antilles to be the site whereon *Pleurodonte* developed, from the fact that six out of the eleven of its sections are wholly confined to that region, as is another, *Thelidomus*, with the exception of a couple of species, while a majority of the species of the genus are also found there. It would seem strange that some ancestral form which had migrated to the Lesser

*The latter is a *Glabaris* no doubt. Ihering has shown (Archiv für Naturgeschichte Jahrg 59, 1 Bd., 1 Heft., p. 52), that all the South American *Anodons*, so called, are anatomically quite distinct from the Unionidæ, and that they belong to the Mutelidæ. This form, *A. leotandi*, Guppy, is no doubt derived from some of the continental species.

†Introduced into the more northern islands, probably on coffee trees.

Antilles should develop into the group *Caprinus*, not a species of which should be found north of this archipelago, and that not one of the six other Greater Antillean groups should be represented in the Windward Isles; that it should develop a few species on the mainland and pass into *Labyrinthus*, no species of which is found outside the continent.

It appears to me a not unreasonable solution of this rather curious phase of distribution, in view of the very slight relationship that otherwise exists between the land and fresh-water mollusks of the Greater and Lesser Antilles, and of the fact that many of the latter islands are of such recent date, that it is more probable that ancestral forms of *Pleurodonte* migrated from Jamaica across the old landway to Honduras; that the subsidence of some 400 miles of this ancient bridge destroyed the connecting links so that *Pleurodonte* restricted developed in the island and *Labyrinthus* on the continent; that the latter (extending now as far north as Central America) spread out over the lower regions of northern South America, and developed into *Isomeria* in the mountains; that from this stock descended *Caprinus*, which is now represented by a few species in Guiana, and probably in the adjacent territory, and which migrated northward among the Lesser Antilles to St. Kitts and Barbuda, its farthest limit.*

To briefly recapitulate, a considerable portion of the land snail fauna of the Greater Antilles seems to be ancient and to have developed on the islands where it is now found. There appears to be good evidence of a general elevation of the Greater Antillean region, probably some time during the Eocene, after most of the more important groups of snails had come into existence, at which time the larger islands were united, and there was land connection with Central America by way of Jamaica and possibly across the Yucatan Channel, and there was then a considerable exchange of species between the two regions. At some time during this elevation there was probably a landway from Cuba across the Bahama plateau to the Floridian area, over which certain groups of Antillean land mollusks crossed. At this time it is likely that the more northern isles of the Lesser Antilles, which seem to be volcanoes of later Tertiary and Post Pliocene date, were not yet elevated above the sea or if so they have probably been submerged since. After the period of elevation there followed one of general subsidence.†

* *Cistula*, which has its metropolis in the Greater Antilles, has a somewhat similar distribution. Several species are found in Mexico, Central and northern South America, with one species in Trinidad, but not north of that until we reach Antigua, near the upper end of the chain. *Neocyclotus*, with a great development in the more northern archipelago, is also abundant on the continent, and is found in the Lesser Antilles as far north as Martinique; and *Colobostylus*, with a similar distribution, extends northward only into Trinidad.

† Just how extensive this disturbed area was can not now be told. It is well known that along the north shore of Cuba, back of Matanzas and Havana, there are raised beaches, some 1,200 feet above the sea, which have been supposed to be recent, but Mr. R. T. Hill, of the U. S. Geological Survey, who has recently visited the island

During this the island of Jamaica—as the character of its land-snail fauna shows, as well as the depth of the channel between it and Haiti—was first to be isolated, then Cuba, and afterwards Haiti and Puerto Rico were separated. The connection between the Antilles and the mainland was broken, and the Bahama region, if it had been previously elevated above the sea, was submerged; the subsidence continuing until only the summits of the mountains of the four Greater Antillean islands remained above water. Then followed another period of elevation, which has lasted no doubt until the present time, and the large areas of limestone uncovered (of Miocene, Pliocene, and Post Pliocene age) in the Greater Antilles have furnished an admirable field for the development of the groups of land snails that survived on the summits of the islands. The Bahamas have appeared above the surface of the sea, either by elevation or growth, and have been peopled by forms drifted from Cuba and Haiti, and a number of land and fresh-water species have been recently colonized in South Florida, probably since the Glacial epoch. The Lesser Antilles have been peopled for the most part from South America, possibly receiving from that region the group *Caprinus*, so characteristic of the former region, as well as several genera of land operculates, while a few stragglers have been carried by sea no doubt from the Greater Antilles and colonized on the more northern of the Windward Islands.

DESCRIPTIONS OF NEW SPECIES OF RECENT AND FOSSIL LAND SHELLS FROM THE ISLAND OF JAMAICA.

I.—*Recent species.*

SAGDA MAXIMA, new species.

Plate XVI, figs. 7, 8.

Shell large, pyramidal in form, with nearly straight sides and obtuse summit, moderately striated, and covered with a thin, horn-colored epidermis; whorls, $8\frac{1}{2}$ to 9, moderately convex; suture distinct and well impressed, sometimes slightly margined; last whorl wide, well rounded; aperture large; base rather flat, not deeply excavated at the umbilical region; the latter covered with a light, glazed callous, which joins the outer edge of the aperture. Interior entirely destitute of a lamella. Greater diameter 30; lesser 27 mm.; height 28 mm. Near Petersfield, Westmoreland, on a mountain, in heavy forest.

This species resembles *S. epistylioides* somewhat, but has a broader, less excavated base, and from one to one and a half less whorls, which are wider than those of the latter, and the shell has not so pointed a summit. Some 25 specimens (all dead) were obtained, varying from

has brought shells from these beaches and submitted them to Dr. Dall, who pronounces them to be Miocene, and probably of the same general age as the Bowden beds of Jamaica. It would seem most likely that the elevation and subsidence would extend to some extent through the Bahamas and into the South Floridian regions.

young to adults, and though several were broken open no vestige of a lamina was observed at any stage of growth.

PLEURODONTE (EURYCRATERA) JAMAICENSIS, Chemitz, var. CORNEA.

A variety of this species was found at Mandeville, Manchester, rather more delicate in structure than the type, and entirely destitute of color, the epidermis being horn-colored.

ADAMSIELLA GRAYANA, Pfeiffer, var. AUREOLABRA.

A large number of specimens of what may prove to be a new species were found at Rio Novo, in St. Mary. The aperture is smoother than that of the type, and is of a rich, reddish-orange color; the body of the shell is shining, and very finely decussated under a glass. The species is exceedingly variable, and this may be only a strongly marked variety.

LUCIDELLA AUREOLA, Ferussac, var. INTERRUPTA.

This variety is covered with interrupted and slightly wavy, revolving striæ, the liræ blotched with white. Duncan's, Trelawney.

II.—*Fossil species.*

NEOCYCLOTUS (PTYCHOCOCHLIS) BAKERI, new species.

Plate XVI, figs. 1, 2.

Shell large, depressed, with 5 well-rounded whorls; nuclear whorl wanting in the only specimen found; second, third, and fourth whorls covered with delicate, radiating, zigzag corrugations, which become very much coarser on the last three fourths of the body whorl; the periphery of the latter being almost smooth, the upper surface becoming very strongly and irregularly waved toward the aperture; the base and umbilical region having strong folds, which sweep forward obliquely toward the periphery; umbilicus rather wide, extending to the summit of the shell, and exhibiting the volutions; umbilical keel almost entirely wanting, there being two very slight revolving elevations, one at the outer edge of the umbilicus, the other farther out on the base, the area between them being flattened so that the shell seems to have two faint keels; aperture moderately large; operculum unknown. Greater diameter 25, lesser 21 mm., height 12 mm.

Locality and position: stratum of marl in the Miocene beds at Bowden, St. Thomas, Jamaica, associated with marine fossils.

I take pleasure in naming this fine species in honor of Capt. L. D. Baker, president of the Boston Fruit Company, who gave us permission to excavate in the beds, and furnished us men and every facility possible to make our work a success.

LUCIDELLA COSTATA, new species.

Plate XVI, fig. 6.

This is a small species, about one-half the diameter of the average *L. aureola.* There are 5 whorls which are moderately rounded; the

suture being shallow and somewhat canaliculate, with about 10 strong, revolving costæ on the body whorl and 5 on the penult whorl, and between these are smaller revolving liræ. The center of the base for about two-fifths of the diameter of the shell is perfectly smooth, and slightly hollowed in the umbilical region. The upper part of the aperture of the only specimen found is broken away, leaving only the basal tooth, which is slightly compressed parallel with the outer edge of the basal lip.

Diameter $3\frac{1}{2}$, height nearly 3 mm.

Found with *Neocyclotus bakeri* and other fossil shells.

PLEURODONTE BOWDENIANA, new species.

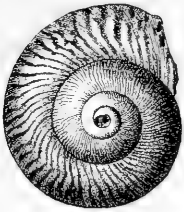
Plate XVI, figs. 3, 4, 5.

Two fragments of this shell were found, an apex with 3 whorls and about one-third of the base of a body whorl with the aperture in perfect condition. The fragment containing the nucleus shows the upper surface of the whorls perfectly plain, the suture being only marked by an elevated line; it has a wide umbilicus and a very sharp keel. The other fragment shows a rather sharply defined peripheral keel; the aperture is very oblique and rather compressed, with two strong teeth, which are somewhat like those of *P. lucerna*, but are set more obliquely with the aperture, the outer one being somewhat flattened on the upper extremity; the lip is thin, not reflected above, reflected and joined solidly to the base along its inner half, the outer basal half is free and well reflected. Back of the basal lip there is a deep, somewhat oblique, oval pit, corresponding exactly with the shape of the outer tooth, and extending within it to its summit. The large umbilicus of the young shell is completely closed by the flattened callous of the lower lip in the adult. The diameter of this shell if perfect would probably be about 40 mm., the height about 15 mm. It was found in company with the other fossils in the Bowden beds. The basal pit behind the aperture is a remarkable character, and I know of no other *Pleurodonte* which has it developed in such a manner.

The *Thysanophora* found with the above fossils is, I believe, new, but it is not in fit condition to describe or figure.

EXPLANATION OF PLATE XVI.

Fig. 1. *Neocyclotus (Ptychocochlis) bakeri*, new species; from above.
Fig. 2. *Neocyclotus (Ptychocochlis) bakeri*, new species; dorsal view.
Fig. 3. *Pleurodonte bowdeniana*, new species; aperture, front view.
Fig. 4. *Pleurodonte bowdeniana*, new species; base.
Fig. 5. *Pleurodonte bowdeniana*, new species; upper view, fragment.
Fig. 6. *Lucidella costata*, new species; front view; upper portion of outer lip broken.
Fig. 7. *Sagda maxima*, new species; front view.
Fig. 8. *Sagda maxima*, new species; basal view.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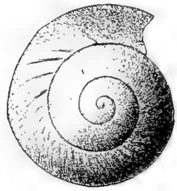
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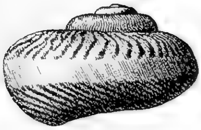
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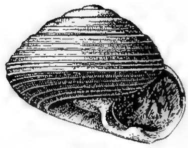
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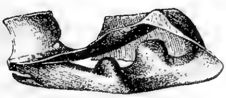
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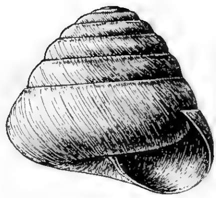
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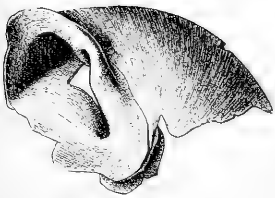
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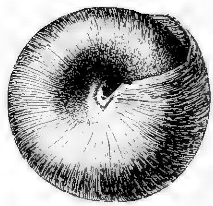
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NEW SPECIES OF MOLLUSKS FROM JAMAICA.

Figs. 1, 2. *Neocyclotus bakeri* (Fossil).
Figs. 3–5. *Pleurodonte bowdeniana* (Fossil).
Fig. 6. *Lucidella costata* (Fossil).
Fig. 7, 8. *Sagda maxima* (Recent).

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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No XXVIII.—ON CETOMIMIDÆ AND RONDELETIIDÆ, TWO NEW FAMILIES OF BATHYBIAL FISHES FROM THE NORTHWESTERN ATLANTIC.

By G. BROWN GOODE and TARLETON H. BEAN.

IN OUR forthcoming work entitled "Oceanic Ichthyology" the three species here noticed will be described and figured. The publication of this work will probably be delayed for several months, and it is thought proper to publish in advance some account of these very interesting forms, each of which is represented by a single specimen.

These are Malacopterygian fishes, belonging to the group set aside by Gill under the name INIOMI. Their relations to the other members of the order are not well understood by us, but they are somewhat closely allied to the Synodontidæ, though lacking scales and the adipose dorsal fin, and having granular teeth arranged in bands.

The family Rondeletiidæ is distinguished from Cetomimidæ by the presence of ventral fins, and the incompleteness of the opercular apparatus.

CETOMIMIDÆ, new family.

Malacopterygian, with body somewhat compressed, scaleless. Head naked. Lateral line conspicuous. No barbels. No photophores. Mouth exceedingly large; the margin of the upper jaw formed by the premaxillaries only; the lower jaw strongly curved, and slightly projecting beyond the upper. Teeth in jaws in bands, granular. The vomer, the palatines, the pterygoids, and also the first gill-arch and the lingual bones (which are greatly enlarged), as well as the upper pharyngeals, are covered with teeth of a similar character. Opercular apparatus incomplete; its bones very thin, membrane-like. Mesocoracoid wanting. Post-temporal connected with back of cranium, near sides. No adipose fin. Dorsal fin far back, short, high, inserted opposite the anal which it resembles. Pectorals short, placed rather low.

Ventrals absent. Gill-opening immense, the membranes deeply cleft, free from the isthmus. Gills 3. Pseudobranchiæ absent.

CETOMIMUS, new genus.

Body oblong, compressed, scaleless; similar in its vertical outline and proportions to that of the right whales (Balænidæ), a resemblance which is greatly enhanced by the shape of the enormous mouth, and in the lower jaw strongly curved, projecting slightly beyond the snout. Teeth in granular bands, covering all the bones of the mouth, tongue, and throat. Mucous pores sometimes present on the back. Nostrils far forward, open slits without flap. Eyes very small, and placed far below the dorsal profile. Gill-membranes deeply cleft, not attached to the isthmus. Gill-rakers absent, replaced by granular tooth-like surface upon the arch. Gills 3; no slit behind the third. Branchiostegals 9. Opercular apparatus incomplete, bones thin and membranous. Dorsal short, high, inserted very far back, directly opposite the anal, which it resembles in shape and size. Caudal peduncle short and slender. Ventrals absent. Pectorals broad and short, placed low. Caudal small, weak, probably emarginate or truncate. Lateral line broad, consisting of two furrows connected vertically by numerous short cross-grooves.

CETOMIMUS GILLII, new species.

Plate XVII, fig. 2.

The height of the body is a little less than one-fourth of the total length; length of head a little less than one-third. Eye minute; contained about 23 times in the length of head, and about eight times in that of snout; inserted midway between the margin of the jaw and the dorsal profile, distant from the former a space contained about $2\frac{1}{2}$ times in the length of the snout. The maxillary reaches very far back, extending to a point behind the orbit equal to $1\frac{1}{2}$ times the length of the snout. The origin of the dorsal is directly above that of the anal, which is inserted a short distance behind the vent; distance from the snout equal to more than four times the length of its own base, and the distance of its termination from the root of the upper rays of the caudal equal to its own greatest height. The anal fin is similar in shape and extent to the dorsal, but has the thirteenth to the fifteenth rays the longest, while the eighth to the eleventh are the longest in the dorsal. The length of these longest rays is about equal in the two fins, and is contained slightly less than three times in the length of the head. The pectoral fin is inserted somewhat below the middle of the body and close to the extremity of the opercular flap. It is broadly lanceolate, and its length is contained about $3\frac{1}{2}$ times in that of the head. Ventrals lacking. Color, blue-black. The lateral line sweeps in a bold curve from a point above the upper angle of the gill-opening to a point in the middle of the body between the origin of the dorsal

and anal fins, and thence in a straight median line to the base of the caudal.

Radial formula: B. 9; D. 16; A. 16; P. 16.

A single specimen (No. 35529, U.S.N.M.), five inches in length, was taken by the *Albatross*, August 20, 1884, at station 2206, in 39° 35′ N. Lat., 71° 24′ 30″ W. Long., at the depth of 1,043 fathoms.

CETOMIMUS STORERI, new species.

Plate XVII, Fig. 3.

The height of the body is a little more than one-fourth of the total length; the length of the head is contained three and one-third times in that of the body. Diameter of the eye contained about eighteen times in the length of the head, and about seven times in that of the snout, the eye being inserted nearer to the dorsal profile than to the jaw, its position in the vertical being twice as far from the line of the upper jaw as from the dorsal lines, it is nearly in the line of the vertical erected from the middle of the upper jaw to the right angles of its edge. The lower jaw is strongly curved, and projects far beyond the upper. The origin of the dorsal fin is a little in advance of that of the anal, which is inserted at a distance from the vent equal to three or four times the diameter of the eye. The dorsal fin is longer than the anal, the termination of the latter being under the fifth ray from the end of the dorsal. They are about equal in height, and the direction of the rays when erected is backward, and at an acute angle with the axis of the body. The longest rays are contained about two and one-half times in the length of the head. Pectoral fin is inserted very far down, the lower portion of its peduncle almost on the abdominal line; the fin is lanceolate, and although mutilated, is believed to have been about half as long as the head. The lateral line sweeps in a sinuous curve from a point above the upper angle of the gill-opening to a point somewhat in advance of the insertion of the dorsal, and thence in a straight line to the base of the caudal. A line of mucous pores on either side of the median dorsal line in advance of the dorsal fin.

Radial formula: D. 19; A. 16.

A single specimen (No. 35634, U.S.N.M.), 4⅗ inches in length, was taken by the Fish Commission steamer *Albatross* at station 2222, December 5, 1884, in 39° 03′ 15″ N. Lat., 70° 50′ 45″ W. Lon., at a depth of 1,535 fathoms.

This species is provisionally described from a careful drawing made by Miss M. M. Smith, December 11, 1884, under the criticism of Dr. Bean, the type specimen having been inaccessible at the time this study was made.

The species is named in honor of Dr. David Humphreys Storer, who died in Boston at the age of eighty years, in September, 1891, in token of our appreciation of the distinguished services of this pioneer in American ichthyology, who began systematic work upon the fauna of the western Atlantic more than half a century ago.

RONDELETIIDÆ, new family.

Body more or less compressed, scaleless. Head naked. No barbels. Mouth large. Margin of the upper jaw formed by the premaxillaries only. Teeth coarsely granular. Opercular apparatus complete; its bones very thin, membrane-like. No adipose fin. Dorsal fin far back; short and low; inserted opposite the anal. Pectorals short, placed rather low. Ventrals present, abdominal. Gill opening very wide; membranes deeply cleft, free from the isthmus. Pseudobranchiæ absent.

RONDELETIA, new genus.

Body oblong, compressed, scaleless. Mouth large; lower jaw slightly projecting. Teeth in bands, coarsely granular in the jaws; vomer and palatines toothless; a row of large mucous pores on the lower surface of the mandible and extending upward on the preoperculum. Posterior nostril with a slender filament anteriorly. Eyes moderate; near the dorsal profile. Snout rather long, obtuse. Supraoccipital bones with a pair of strong spines projecting horizontally forward over the orbit. Gill-membranes entirely separate; gill-rakers numerous, rather long and slender. Gills 4; a narrow slit behind the fourth. Branchiostegals 7. Opercular bones thin, membranous. Dorsal short, rather low, opposite and similar to the anal. Pectorals and ventrals small. Caudal small, probably forked. No vestiges of a lateral line.

This genus is dedicated to Rondelet, the French ichthyologist of the seventeenth century.

RONDELETIA BICOLOR, new species.

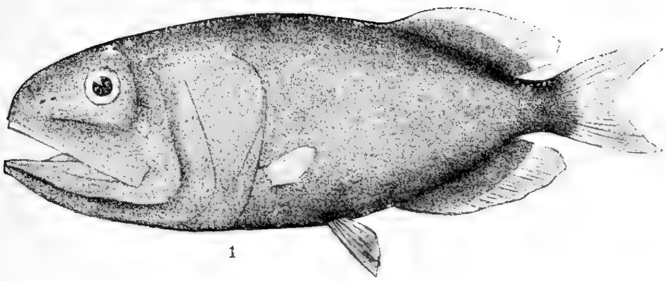
Plate XVII, Fig. 1.

The height of the body is a little less than one-third of the total length; length of the head nearly one-half. Diameter of the eye contained six times in the length of the head, and twice in the length of the snout. The maxillary reaches to below the hind margin of the eye, and the intermaxillary about as far. Origin of the dorsal fin nearly opposite the vent. The anal origin immediately behind the vent, the terminations of the two opposite. The fins are low, the rays pointing horizontally backward; the longest ray in the dorsal fin about one-fifth of the length of the head, and the longest in the anal, one-fourth. The pectoral fin inserted below the middle of the body, and under the end of the opercular flap; its length nearly one-fourth that of the head. Ventrals inserted behind the middle of the total length, and still farther behind the tips of the extended pectorals; their length about two-ninths that of the head, and when extended reaching beyond the vent.

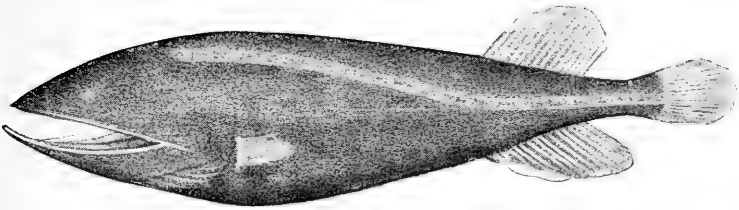
Color, purplish-black, with cherry-colored margins to the fins; whitish in spirits.

Radial formula: B. 7; D. 14; A. 14; P. 9; V. 5.

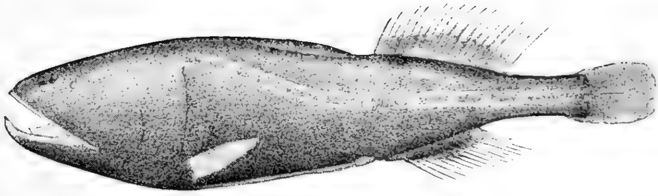
A single specimen (No. 38202, U.S.N.M.), $4\frac{1}{4}$ inches in length, was taken by the Fish Commission steamer *Albatross* at station 2724, Lat. 36° 47′ N., Lon. 73° 25′ W., at a depth of 1,641 fathoms.



1



2



3

NEW SPECIES OF BATHYBIAL FISHES.

Fig. 1. *Rondeletia bicolor*, Goode and Bean.
Fig. 2. *Cetomimus gillii*, Goode and Bean.
Fig. 3. *Cetomimus storeri*, Goode and Bean.

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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No. XXIX.—A REVISION OF THE ORDER HETEROMI, DEEP-SEA FISHES, WITH A DESCRIPTION OF THE NEW GENERIC TYPES MACDONALDIA AND LIPOGENYS.

By G. Brown Goode and Tarleton H. Bean.

[Abridged from advance sheets of *Oceanic Ichthyology*.]

The collection of heteromous fishes obtained by the U. S. Fish Commission includes representatives of three of the five known genera of the order. The first species was taken in 1880 by a New England fishing vessel from the stomach of a ground shark on the Grand Bank of Newfoundland. The *Albatross* secured its first specimen (a *Macdonaldia*) in 1884 off the coast of New Jersey, and again, in 1887, dredged a second specimen of the same species in nearly the same locality.

In 1886 this vessel collected several examples of *Notacanthus analis* west of the Bermudas, and in 1887 *Lipogenys* was dredged off the Maryland coast.

Heteromi have been recorded from the Arctic, the Mediterranean, north and south Atlantic, and north and south Pacific, in depths ranging from 100 to upward of 1,800 fathoms.

Order HETEROMI.

Notacanthi, Bleeker, Tentamen, 1859, xxiii. (In part.)
Heteromi, Gill, American Naturalist, November, 1889, p. 1016.

Teleosts with the scapular arch formed by the proscapula and post temporal (or posterotemporal), the latter detached from the sides of the cranium, and impinging on the supraoccipital; the hypercoracoid and hypocoracoid coalesced into a single lamellar imperforate plate; the actinosts normal; the cranium with the condyle confined to the basioccipital (ill defined); the exoccipitals coalesced with the epiotics and opisthotics; the vomer obsolete; the opercular apparatus complete, but the preoperculum slightly connected with or discrete from the suspensorium; the suborbitals suppressed; the jaw bones complete and little aberrant; the palatines, entopterygoids, and ectoptyergoids well developed; the anterior vertebræ separate, and the ventrals abdominal. (Gill.)

All the heteromous teleosts have a subfusiform, moderately compressed body, with head and snout protruding, and sometimes produced and proboscis-like as in *Polyacanthonotus*.

Family NOTACANTHIDAE.

Notacantini, RAFINESQUE, Indice d'Ittiologia Siciliana, 1810, p. 34.
Notacanthini, BONAPARTE, Cat. Metodico, 1846, p. 72.
Notacanthoidei, BLEEKER, *l. c.*
Notacanthi, GÜNTHER, Cat. Fish. Brit. Mus., III, 1861, p. 544.
Notacanthidæ, GILL, Arr. Fam Fish., 1872, p. 21; Johnson's Cyclopædia, III, 1883, Century Dictionary, IV, 4022.—JORDAN and GILBERT, Bull., U. S. Nat. Mus., XVI, p. 370.

Heteromous teleosts, with elongate, subfusiform, moderately compressed body. Head short and snout protruding, sometimes produced, proboscis-like (as in *Polyacanthonotus*). Mouth moderate, horizontal, or inferior, suctorial (as in *Macdonaldia*). Scales small on body and head; lateral line present. Teeth slender, closely set, in a single series in each jaw. Gill-openings wide, the membranes separate and free from the isthmus.

Dorsal fin median, with short and free dorsal spines, and with soft rays very few or absent. Anal fin long, rather high, extending from the middle of the body to the caudal, with which it unites, and with numerous spinous rays. Ventrals abdominal, often confluent, with 1–5 spines and 4–8 soft rays. Pectorals short and high. Pseudobranchiæ, none.

The elaborate anatomical description of *Notacanthus sexspinis* given by Günther* with numerous excellent figures, applies in its general features to all the members of this family.

In the discussion of the genera and species below, little attention has been given to the degree of connection of the ventral fins. In every instance these are connate or confluent, but the degree of connection depends not so much upon their proximity to each other as upon the extent of the connecting membrane in the several forms, and we question whether the character can be so defined as to serve even for specific distinctions.

All the species examined by us have the peculiar modification of the posterior extremities of the maxillary, and the sharp spine more or less hidden by the fleshy fold of the lips at the angle of the mouth on either side.

KEY TO THE GENERA OF NOTACANTHIDÆ AND LIPOGENYIDÆ.

I. Jaws normal. Dorsal spines separated. Teeth in both jaws.
  A. Dorsal spines 6–12. Teeth in upper jaw compressed, and obliquely triangular. Ventrals connate or confluent .... NOTACANTHIDÆ.
    1. Origin of spinous dorsal far in advance of vent. Mouth lateral. Ventral fins connate or confluent .... NOTACANTHUS.
    2. Origin of spinous dorsal in vertical from vent. Mouth subinferior, crescentic. Jaws each with 22 teeth. Ventral fins united.... GIGLIOLIA.

* *Challenger* Report, XXII, p. 243–8.

B. Dorsal spines 27–38. Teeth in jaws erect, fine. Ventrals separated..... ........POLYACANTHONOTINÆ.

1. Snout proboscis-like. Dorsal and anal spines long, flexible, the latter not exceeding 30 in number. Lateral line strongly arched....... ........POLYACANTHONOTUS.

2. Snout not very elongate. Dorsal and anal spines low and strong, the latter 50 or more in number. Lateral line straight....MACDONALDIA.

II. Jaws modified to form a suctorial mouth. Dorsal spines close together, united by membrane to form a high triangular fin............LIPOGENYIDÆ.

A. Dorsal spines 5, with 5 soft rays.

1. Lateral line obsolete........LIPOGENYS.

Genus NOTACANTHUS, Bloch.

Notacanthus, BLOCH, Abhandl. Böhm. Gesellsch., 1787.—LACÉPÈDE, Hist. Nat. Poiss., 1804.—Goode, Proc. U. S. Nat. Mus., III, 1880, p. 555.

Acanthonotus, BLOCH, Ichthyologia, XII, 1797, p. 113, pl. CCCCXXXI. (No description separate from that of species *A. nasus*.)—SCHNEIDER, Bloch, Syst. Ichth., 1801, p. 390, pl. XLVII.

Campylodon, FABRICIUS (*fide* GÜNTHER).

KEY TO THE SPECIES OF NOTACANTHUS AND GIGLIOLIA.

I. Origin of dorsal considerably in advance of that of anal. Lip normal, continuous........NOTACANTHUS.

A. Body much higher over ventrals than over pectorals, and comparatively short.

1. Lateral line in front of dorsal spines, following profile of back, then sinking to median line of body. D. X–XI.

a. First dorsal spine behind vertical from axil of ventral. A. XIII–XIV. (XVII?)........N. NASUS.

b. First dorsal spine in front of vertical from insertion of ventral. A. XVII........N. ANALIS.

B. Body little higher over ventrals than over pectorals, and comparatively elongate.

1. Lateral line inconspicuous, nearer to dorsal than to ventral outline throughout, not arched anteriorly. D. VI–VIII.

a. Last dorsal spines over anterior part of soft anal. A. XII. N. BONAPARTII.

b. Dorsal and soft anal not passing same vertical. A. XIII–XIV. N. SEXSPINIS.

2. Lateral line slightly arched above pectoral, sinking to median line of body in advance of first dorsal spines. D. X.

a. Last dorsal spine over fifth from last anal spine. Fins low. A. XIX. N. PHASGANORUS.

II. Origin of dorsal over the vent. Lip absent in middle portion ....GIGLIOLIA.

A. Body much higher over ventrals than over pectorals; comparatively short.

1. Lateral line arched over ventrals and pectorals. D. VIII.

a. Snout thick, swollen. A. XV–XVIII........G. MOSELEYI.

NOTACANTHUS NASUS (Bloch), Jordan and Gilbert.

Acanthonotus nasus, BLOCH, Ausl. Fische, XII, p. 114.—SCHNEIDER, Bloch's Systema Ichthyologiæ, 1801, p. 390.

Notacanthus nasus, BLOCH, Fische, VII, p. 113, pl. 431.—CUVIER and VALENCIENNES, Hist. Nat. Poiss., VIII, p. 467, pl. CCXXLI.—LÜTKEN, Vid. Med., 1878, p. 145.—GÜNTHER, Cat. Fish. Brit. Mus., III, p. 54; *Challenger* Report, XXII, p. 248.—GIGLIOLI, Elenco, 94.—VAILLANT, Voy. Travailleur and Talisman, p. 317.

Campylodon fabricii, REINHARDT, Vidensk. Selsk. Afhandl., 1838, p. 120.
Notacanthus chemnitzii, BLOCH, (Abh. Bohm. Gesellsch., 1787).—JORDAN and GILBERT, Bull. U. S. Nat. Mus., XVI, p. 370.

A Notocanthus with elongate body, whose greatest height lies between the pectoral and ventral fins and is contained about four and one-half times in the distance from the vent to the tip of the snout. Head short, compressed, its length not quite three and one-half times in the distance from vent to snout. Mouth large, extending backward to a point nearly under the eye; the maxillary nearly to the vertical from the anterior margin of the pupil. The mouth does not lie entirely on the under portion of the head, but is sublateral. There are thirty-five teeth in the intermaxillaries on each side. The distance between the upper profile of the head and the eye is about equal to the diameter of the eye, which is slightly greater than one-third the length of the snout (certainly not more than one-half the length of the snout) and about one-eighth the length of the head. [In this connection it is taken for granted that the hole in the skin of the head represents the size of the eye. If, however, we assume that the entire portion free of scales is the eye, the diameter is greater and equal to one-sixth the length of the head. It is, at any rate, considerably less than the width of the inter-orbital space.] The gill-cover appears to be divided to below the symphysis of the operculum (with hyomandibular), and is free from the isthmus.

Scales are lacking only about the mouth and eyes; about forty rows of small scales (2 mm. broad, 4 mm. long) between the ventral outline and the lateral line; smooth and imbricated.

Of the eleven dorsal spines, the first (overlooked by Bloch and Valenciennes) is very small and only visible as a point; placed close to this (1 mm.) is the second, which is also very short and feeble. The third, though also short, is thicker. The vent lies behind the fifth spine. Of the fifteen anal spines, which have their origin immediately behind the vent, the first (overlooked by Bloch and Valenciennes) is very small; it does not extend beyond the profile; the second and third but slightly. The spines which are longest and placed farthest back still bear traces of a connecting membrane, and are probably only worn-off rays. The pectorals are inserted somewhat farther back from the gill-covers than shown by Bloch; the end is surely broken off, but yet it can hardly be doubted that this fin is too long in Bloch's figure; its base is less than one-sixth the length of the head. The ventral fins, connected together behind the median line by a membrane, terminate considerably in advance of the vent (they are apparently worn off a little behind).

Radial formula: D. 11; A. 15 + 118. C?; P. 19; V. 3 + 7 (l), 8 (r); Branchiostegals VIII. (r)—IX. (l).

Total length (restored), 85 cm. Length of head, about 10.7 cm. Height of body, about 8 cm. Length of caudal, about 47.5 cm.

The full diagnosis given above was furnished by our friend Dr. Franz Hildgendorf, custos of the zoological collections in the Royal Museum of Natural History, Berlin, who also gives the following notes on the present condition of the type:

The original Bloch specimen (Cat. gen. No. 1409) is still in existence (our museum possesses in addition to this only a single specimen of *Notacanthus*, *Notac. sexspinis*), but it is in a very unsatisfactory condition. It was perhaps injured in transportation from Paris. The jar has not been opened for more than thirty years. Very likely Bloch received it in a poor state of preservation—a large cavity in the belly between the pectorals and ventrals, a dilapidated left cheek, injured eyeballs, intestines wanting, etc. In addition to this, there are other defects of a later date, such as the loss of the caudal, the tip of the snout, the maceration of the frontal bones. The gill arch is almost entirely gone; the intestines altogether. The frontal bone is crushed and the first vertebra is disconnected. There is a long gap in the dorsal fin.

The actual length is now 82 cm.; in addition to this should be added at the most 1 cm. for the snout and ⅔ cm. for the caudal fin. This makes its former length about 85 cm. (Bloch says 2½ feet. This would be according to the Rhenish, i. e., Prussian, measure only 78½ cm. Perhaps Bloch had a longer foot, or he gave only an approximate measurement.) As we have no other specimen which we might have confounded with that of Bloch, and ours still bears the label (apparently in Troschel's handwriting), "*Notacanthus nasus*, Iceland, Bloch," I have no doubt that No. 1409 is the type specimen. Nor can there have been another in Paris.

How much of the end of the caudal is missing is difficult to say. The point of the fracture is hard and the fin bones are soft. If Valenciennes's account is accurate, the caudal *fin* only is missing, and one or two rays of this are still attached. If Bloch's description is correct, there were 149—(13, 8, or 10? spines for the caudal),=126-128 rays in the anal; consequently a caudal end, with at least 10 rays, in addition to the caudal fin, was lost, and the fish would have been somewhat longer than 85 cm. I presume there was an oversight on Bloch's part.

The material now classed by authors under the name of *N. nasus* is the following: (1) A specimen described by Fabricius in 1798 under the generic name of *Campylodon*, obtained in 1794 from Greenland; (2) Bloch's type in the Berlin Museum, believed by him to come from the West Indies, described under the names *N. chemnitzii* (?), *N. nasus*, and *Acanthonotus nasus;* (3) a specimen, obtained off Iceland by *La Recherche* and brought by Gaimard to the Paris Museum, figured in the Règne Animal, and said to have been figured also in the Voyage in Scandinavia; this, as has already been stated, is possibly a typical *N. nasus;* (4) a specimen, 3 feet long, obtained in South Greenland, and brought in 1877 to the Copenhagen Museum. This also is possibly not a characteristic representative of the species.

Both Canestrini and Giglioli enumerate *Notacanthus nasus* among Mediterranean fishes, but entirely without warrant.

NOTACANTHUS ANALIS, Gill.

Notacanthus analis, Gill, Proc. U. S. Nat. Mus., VI, 1838, p. 255.—Günther, *Challenger* Report, XXII, p. 248, note.—Vaillant, Voy., Travailleur and Talisman, p. 318, *et seq.*—Jordan and Gilbert, Cat. Fish. N. Amer., 1885, p. 58.

A *Notacanthus*, with its body much higher over ventrals than over pectorals, and comparatively short. Its height equal to one-third of the distance from the vent to the tip of the snout, and nearly equal to

the length of the head. The lateral line arcuate in front of the dorsal spines, following profile of the back, and then sinking to the median line of the body. First dorsal spine in front of vertical from insertion of ventral.

The snout is compressed, pointed, much produced beyond the moderate mouth. The cleft extends nearly to the vertical through the middle of eye. The length of the snout is one and one-half times the diameter of the eye. The width of the interorbital area is slightly less than the diameter of the eye. The projection of the snout beyond the mouth equal to the diameter of the eye, or nearly so. The snout is compressed, not swollen. Mouth narrow, transverse, its width about one-fourth the length of the head. The eye is placed some distance below the upper profile and in the line of the lateral line continued to the nostrils. Gill-opening wide; the membranes confluent and slightly in advance of the vertical from the upper end of the gill-opening; not attached to the isthmus. Scales very minute, imbricated, adherent.

All the dorsal spines are short, the anterior very short; the second and first nearly over the origin of the ventrals, the fifth above the vent, and the sixth slightly behind the origin of the anal. The longest about one-half as long as the eye. The last (eleventh), which is followed by a single ray attached to it by membrane, is over the fifteenth spine of the anal. The dorsal spines are distant from each other, and behind each is a narrow angular membrane. The anal begins immediately behind the vent and in its middle portion is considerably elevated; the length of its longest rays are about equal to that of the snout, from which point it slopes rapidly to the tip of the tail. The pectoral, placed high up in the middle axis of the body, is inserted at some distance behind the gill-opening and is broad and nearly oval in shape. Ventrals confluent, some distance in advance of the vent, stout, broad, ovate in form, not extending to the vent but separated from it by a distance equal to half their own length. Color uniform light brown.

Radial formula: D. XI; A. XVIII+.

This description is prepared from the types of Gill, (No. 37856, U.S.N.M.) from *Albatross* station 2677, N. Lat. 32° 39′ W. Lon., 76° 50′ 30″, in 478 fathoms. The types, two in number, measure $11\frac{1}{2}$ and $12\frac{1}{2}$ inches, respectively. Another specimen (No. 44246, U.S.N.M.) was obtained by the *Albatross* from station 2676, in 32° 39′ N. Lat., 76° 01′ W. Lon., at a depth of 407 fathoms.

NOTACANTHUS BONAPARTII, Risso.

Notacanthus bonaparti, RISSO, Wiegm. Archiv f. Naturgesch., 1840, p. 376, pl. X.

Notacanthus bonapartii, FILIPPI and VERANY, Mem. Acc. Sci. Torino, XVIII, 1857, p. 190, Notad 6.—CANESTRINI, Pesci d'Italia, p. 118.—MOREAU, Hist. Nat. Poiss. France, 1881, p. 161.—GIGLIOLI, Elenco, 33.

Notacanthus mediterraneus, FILIPPI and VERANY, Mem. Acc. Sci. Torino, 2d series, XVIII, 1859, p. 190 (*nota supra*); Alcuni Pesci del Mediterraneo, 1857, p. 3.—GÜNTHER, Cat. Fish. Brit. Mus., III, p. 545.—CANESTRINI, Pesci d'Italia, 1872, p. 118.—MOREAU, Hist. Nat. Poiss. France, 1881, III, p. 158 (woodcut).—VAILLANT, Voy. Travailleur and Talisman, p. 317; p. 325, pl. XXVII.

A *Notacanthus*, with body slender, comparatively elongate, little higher over ventrals than over pectorals; with its lateral line inconspicuous, nearer to the dorsal than to the ventral outline, not arched anteriorly. Snout produced and compressed. Palatine teeth in a single series. Ventrals joined by a membrane of considerable width between the internal rays. The height of the body is about one-thirteenth of its length; its thickness, about one-twentieth. The tail does not appear to be in the least truncated, though so described by certain authors, one of whom in his figure shows a tail carried to an acute point, making the length of the body considerably greater in proportion to its height than is indicated in his own description. Color yellowish, with silvery reflections; the limb of the operculum, the margin of the orbit, and the mouth darker.

Radial formula: D. VI–VII; A. XII–100+; V. II, III–6 (IV–8 according to Filippi and Verany).

This form was carefully figured and described by Risso in 1840. He had a single specimen 148 millimeters long, which he recognized as an inhabitant of abyssal depths (*Sejeur abymes marines vaseux*). By some error his description and figure, otherwise perfectly consistent, disagreed in respect to the number of spines in the dorsal fin, the figure showing 7, the description 9. Misled by this, Filippi and Verany redescribed the same fish in 1859, and to justify their course proposed the theory that Risso's descriptions and figures were based on different specimens—a theory accepted without criticism by later writers, but which we can not believe a true one.

Risso was a careful and experienced worker, and it would be unjust to the memory of one of the best Italian ichthyologists to admit that he could be guilty of such an error. Then, too, he states positively that he had only a single specimen. It is much more probable that the German typesetter in the office of Wiegmann's Archiv mistook a "7" for a "9" in Risso's manuscript.

Risso's figure is a good one of a young *N. mediterraneus* and his description agrees with it perfectly with the exception of this one figure in type.

The specimen described and figured by Günther under the name *N. mediterraneus* is not a Mediterranean form, but one from the Southern Pacific, and has been referred by us to a new genus and species.

Moreau is in error in referring the figures of Bloch and Cuvier and Valenciennes to this species. (*See* discussion under *Notacanthus nasus*.)

N. bonapartii was described under the name *N. mediterraneus* by Filippi and Verany in 1857 from a specimen obtained at Nice, and preserved in the Zoological Museum at Turin. Two others from the same locality, referred by Moreau to this species, are in the museum in Paris. The *Travailleur* and *Talisman* obtained four additional individuals, one from the coast of Soudan, at a depth of 1,232 meters, and another

from the same region at 932 meters; two from the Banc D'Arguin at 1,495 meters. These last have been made the subject of an elaborate description by Vaillant, who also publishes a good figure.

This species is distinguished from *N. sexspinis*, (fig. 192A–B), described by Richardson from Australian Seas* and subsequently described by Günther, who also gives an excellent figure † by the various characters, most striking of which is the difference in the relationships of the position of the dorsal spines and the soft anal fin. In *N. sexspinis* the dorsal and soft anal do not pass the same vertical, whereas in *N. mediterraneus* the last three dorsal spines are placed over the anterior part of the soft anal. The National Museum is indebted to Dr. Günther for a specimen of *Notacanthus sexspinus* from New Zealand (No. 12625, U.S.N.M.). It is a small specimen, and does not exhibit any inflation of the cheeks, such as is shown in the plate in the *Challenger* report. It has eight dorsal spines.

The type of *N. mediterraneus* from Nice was examined by Giglioli at the Turin Museum in 1882. Its total length is 203 mm., and its radial formula D. 6 / 1; A. 12 / 132?; V. 3–4 / 8; C. 5?.

Prof. Giglioli informs us that in his "Central Collection of Italian Vertebrates" at Florence he has four specimens of *N. bonapartii*, as follows:

a. Nice, August 11, 1882. Total length, 153 mm. D. 8 / 1; A. 6–7 / 120; V. 3 / 6–7; P. 9–10; C. 3–4 ?. A large curved spine in upper corner of mouth on either side.

b. Nice, March 7, 1891. Total length, 205 mm. D. 7 / 1; A. 14 / 120; V. 3 / 7. P. 12. C. 4?. Buccal spines hidden in skin.

c. Nice, June 15, 1892. Total length, 203 mm. D. 7 / 1. A. 8 ? / 140. V. 3 / 5–7. P. 10 / 12. Buccal spines large and prominent.

d. Syracuse, 1855–'60?. D. 7 / 1. A. 11 / 25. P. 9–10. V. 3 / 5. Tail broken off. Buccal spines conspicuous.

Another specimen, collected by Bellotti at Messina, December 12, 1882, and now in the Museo Civico at Milan, was examined by Giglioli, who states that it was 104 mm. long, and had D. 7 / 1. A. 7 / ?. V. 3 / 6. P. 10–12. C. 5 ?.

NOTACANTHUS PHASGANORUS, Goode.

Notacanthus phasganorus, GOODE, Proc. U. S. Nat. Mus., III, p. 535, Apr. 18, 1881.—GÜNTHER, *Challenger* Report, XXII, p. 249.—JORDAN and GILBERT, Bull. U. S. Nat. Mus., XVI, p. 900.—VAILLANT, Voy. Travailleur and Talisman, p. 318 *et seq.*

A *Notacanthus*, with its body a little higher over the ventrals than over pectorals, and comparatively elongate; with its lateral line slightly arched above the pectorals, sinking to median line of body in advance of first dorsal spines, and its last dorsal spine over the fifth from the last anal spine.

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*Voyage Erebus and Terror, Fishes, p. 54, pl. XXXII, figs. 4–11.

† Voyage of the Challenger, XXII, p. 243, pl. LXI, fig. *a*.

Its body is much compressed, its greatest width slightly more than one-third height of the body at vent.

Scales round, thin, flexible, very small upon the head (not wider than the diameter of one of the dorsal spines), but upon the anterior half of the body about three times as large, decreasing in size upon posterior half, until upon tail they are smaller than upon head. Number of scales in lateral line not far from 400. (In the partially digested specimen before me it is impossible to make an exact enumeration.) Number between lateral line and dorsal fin, about 20; between lateral line and anal fin, about 36. Head covered in every part, even the lips, with small scales, of which there are about 40 between eye and end of opercular flap. Scales deeply embedded (in life are probably hidden beneath a slimy epidermis).

Length of the head about $7\frac{1}{3}$ in that of body. Bones are all flexible, and their outlines are invisible without dissection, the whole being covered with a leathery skin. Width of interorbital space appears to be (in the mutilated head) somewhat greater than length of snout and about one-fourth length of the head. Diameter of orbit appears to be about one-half width of interorbital space. Length of postorbital portion of head nearly three times that of snout. Length of mandibular bone slightly exceeds twice diameter of eye; that of upper jaw considerably greater. Teeth in upper jaw blunt, acicular, set side by side like the teeth of a comb, about 32 on each side. In lower jaw shorter, slenderer, and in double rows. Villiform teeth upon palatines.

Dorsal fin begins at a distance from snout not far from two and three-fourth times length of the head, and nearly over the one hundred and tenth scale of lateral line; it consists of ten low, widely separated spines, unconnected by any membrane. Distance between first and tenth spine nearly double length of head.

Spines from fourth to ninth about equidistant, while the other interspaces are shorter.

Distance from snout to anal fin equal to about four times length of head. Anterior spinous portion of anal resembles dorsal and is devoid of connecting membrane. (The membrane is also absent from the posterior half of the fin, but may possibly have been destroyed.) Anal rays extend to tip of tail and number about 130, the number of spines being 19. Anal begins immediately behind vent, and its length of base is slightly less than half that of body (less by a length about equal to the distance from the angle of the mouth to the gill-opening).

Pectoral fin placed at a distance behind the gill-opening about equal to width of its own base (its length is at least double this distance—how much more can not be determined, but the fin is evidently short and rounded in contour, the upper rays longest). Its base is stout-peduncular, and thickly covered with scales.

Distance of the ventrals from snout equal to that of the dorsal,

though its insertion is slightly in advance of that of dorsal. Ventrals closely adjacent, separated by narrow groove, broad, with peduncle-like bases, thickly covered with scales, and are provided with two spines and eight or nine (as nearly as the specimen will permit determination) rays.

Radial formula: D. x; A. xix (130); C. 0; P. (17); V. ii, 8–9.

The U. S. Fish Commission received the type from the schooner *Gatherer*, of Gloucester (Capt. Briggs Gilpatrick), which had been taken from the stomach of a Ground-shark (*Somniosus brevipinnis*), on the Grand Bank of Newfoundland.

GIGLIOLIA, new genus.

A genus of *Notacanthidæ*, distinguished from *Notacanthus* by the less advanced position of the dorsal, the first dorsal spine being placed in the vertical over the vent and close to the vertical from the first anal spine. Dorsal spines 6–9; anal spines 15–18, these being longer and more slender than in *Notacanthus*, enveloped nearly to their tips in a membrane, and grading imperceptibly in length and size into those of the anal, which is comparatively high. The greatest height of the body is in the region of the ventral fins, and the lateral line, which is conspicuous, is arched over the pectorals and ventrals, but follows closely the dorsal outline until it passes beyond the dorsal spines, after which it is directed in a straight line to the tip of the pointed tail. Head comparatively broad, mouth inferior, almost suctorial; teeth in each intermaxillary 20–22; snout thick, swollen, much produced, nostrils large, conspicuous, covered by a membranous flap. Pectoral short, broad, rounded. Ventrals placed low down and completely united, extending to the vent.

In general appearance and proportions this form resembles the high-backed division of the genus *Notacanthus*, to which belong *N. nasus* and *N. chemnitzii*. Its mouth, however, is placed more on the under surface of the head than even in *N. sexspinis*, and resembles in some respects that of our new genus *Macdonaldia*.

This genus is named in honor of Commendatore Enrico Hillier Giglioli, professor in the University of Florence and founder of the Central Museum of Italian Vertebrates, who has been identified with all the efforts of the Italian Government in deep-sea research, and whose thorough works upon the geographical distribution of Italian vertebrates, both terrestrial and aquatic, are of an importance which can not be overstated.

The only species assigned to this genus is that obtained by the *Challenger* off the southwest coast of South America, and referred by Günther to *Notacanthus bonapartii*. For this form, represented by a single individual 11½ inches long, from a depth of 400 fathoms at station 1310, we propose the specific name *moseleyi*, in memory of the lamented Henry

Nottidge Moseley, F. R. S., naturalist of the *Challenger*, and later Linacre professor in the University of Oxford.

GIGLIOLIA MOSELEYI, new species.

Plate XVIII, fig. 1.

Notacanthus bonapartii, GÜNTHER, *Challenger* Report, XXII, 249, pl. lxi, fig. c.

The following excellent description is by Dr. Günther:

Body moderately elongate, its greatest depth opposite to the ventral fin, and contained twice and two-thirds in distance of the vent from the end of the snout; the length of the compressed oblong head is contained twice and one-third in the same length. The snout is thick, swollen, much produced beyond the narrow transverse mouth, which is opposite to the front margin of the orbit, and quite at the lower side of the head. Twenty teeth on each side of the upper jaw. The eye is close to the upper profile, two-thirds of the length of the snout, one-fifth of that of the head, and less than the width of the interorbital space. Gill openings of moderate width, the gill membranes being confluent in the vertical from the upper end of the gill opening, and not attached to the isthmus.

The whole body and head are covered with minute, smooth, imbricate, and adherent scales.

All the dorsal spines are short, the anterior very short, the second opposite to the vent. The anal spines commence immediately behind the vent and increase in length posteriorly, passing into the flexible rays, which are of varying and indefinite number. The pectoral is inserted at the usual distance from the gill opening and has a base of moderate width. Ventrals united and extending to the vent (Günther).

Radial formula: D. VIII-IX; A. XV-XVIII, 150; C. 3; P. 9; V. I, 7; Cæc. pyl. 5.

Genus POLYACANTHONOTUS, Bleeker.

Polyacanthonotus, BLEEKER, GÜNTHER, *Challenger* Report, XXII, 1875, p. 243 (as subgenus.

Zanotacanthus, GILL, Johnson's Cyclopædia, III, 1876, p. 883.

Paradoxichthys, GIGLIOLI, Nature, XXV, p. 535, 1882.

Teratichthys, GIGLIOLI, *l. c.*

Notacanthids, with very slender, elongate body, and inferior mouth, and the snout prolonged into a proboscis-like tip, resembling that of *Mastacembelus*, its length at least one-third that of the head. Dorsal fin represented by numerous slender, curved, flexible, disjoined spines, the first of which is placed some distance behind the vertical from the origin of the pectoral. Anal composed of a smaller number of longer, slender, flexible spines, passing at a point some distance behind the last of the dorsal spines into a low, short, anal fin. Pectorals moderate, slender, placed above the median line of the body, and close to the lateral line. Ventrals slender, entirely separate, not reaching to the vent. Scales inconspicuous or probably absent. Lateral line conspicuous, descending from the angle of the operculum in a strong, broad curve, to below the middle region of the body at a point not far from the vent. Teeth very fine, in rows upon each jaw; stronger teeth upon

the palate, arranged in the form of a horseshoe. The ventral with one spine. Type, *Notacanthus rissoanus* (Filippi and Verany.)

POLYACANTHONOTUS RISSOANUS (De Filippi and Verany), Günther.

Notacanthus rissoanus, DE FILIPPI and VERANY, Mem. Acc. Sci. Torino, 2d ser., XVIII, 1859, p. 6; Nota Sopra alcuni Pesci del Mediterraneo, 1857, p. 3.—GÜNTHER, Cat. Fish. Brit. Mus., III, p. 545.—CANESTRINI, Pesci d'Italia, p. 118.—GIGLIOLI, Elenco, 34; Nature, XXV, p. 535.—MOREAU, Hist. Nat. Poiss. France, p. 162.—VAILLANT, Voy. Travailleur and Talisman, 335, pl. xxvii, fig 1.

[*Notacanthus* (*Polyacanthonotus*) *rissoanus*, GÜNTHER *Challenger* Report, XXII, p. 250 (description and figure relate to another species).]

Paradoxichthys garibaldianus, GIGLIOLI, Nature, XXV, p. 535.

A Notacanthid fish, slender and elongate in form, its greatest height above the anus and near the middle of the body, one-fifteenth of the length of the body; its height at the shoulders about one-twentieth. The length of the head is about one-eighth of that of the body. Snout very elongate, one-third of the length of the head; as long as the height of the body at the shoulders and three times the diameter of the eye. In form resembling that of *Mastacembelus*. "The condition of the type," remarks Vaillant, "does not allow us to estimate the size of the mouth, but its connature does not reach the anterior edge of the orbit. Its form is analogous to that in other species of the genus, that is to say, its inferior teeth are exceedingly fine and closely set in the jaws, while there are stronger teeth upon the palate, where they are arranged in the form of a horseshoe."

Eye moderate in size, its diameter one-eighth the length of the head; interorbital space very narrow, not one-half the diameter of the eye. Branchial opening large. Operculum truncated posteriorly.

Vent in front of the middle of the body.

No traces of scales. The lateral line, however, is conspicuous, and it descends from the upper angle of the operculum to the middle of the body, or a little below it, in the vicinity of the region of the vent. The first dorsal spine is placed two-thirds times its own length back of the vertical from the axil of the pectoral, and its length is less than the diameter of the eye. The highest dorsal spines, those in the posterior third of the fin, are twice as long as the diameter of the eye. The spines are all slightly curved backward, and there is a soft, supplementary ray behind the last. The anal spines are longer than the dorsal spines, the longest two and one-half times the diameter of the eye. The first, which is somewhat longer than the first dorsal spine, situated immediately behind the vent under the eighteenth dorsal spine.

In the specimen figured and described by Vaillant there is a semblance of a minute, separate caudal fin, but it is by no means certain that this exists. The pectoral is placed a considerable distance from the operculum, nearly equal to the length of the snout, and its lower axil is in the median line of the body, or nearly so. Its length is about equal to that of the snout. The ventrals, situated at a distance

from the snout equal to about one-third of the length of the body, do not reach the anus, and are the same size as the pectorals. In Vaillant's specimen they appear to be separate, and he was able to observe but a single spine. The color, in fresh condition, was milky white; the head and iris being black.

Radial formula: D. 29–37; A. 34–41.

This species was known to Risso, who had in his collection the specimen which afterwards served De Filippi as a type and which is now in the Turin Museum. A sketch by Risso of this fish, to which he never gave a name, is given in "Oceanic Ichthyology." The Turin specimen was examined by Prof. Giglioli in 1882; it is 160 mm. long and has the following radial formula: D. 29/1; A. 35.

Prof. Giglioli has three specimens in his collection at Florence. We are indebted to him for the following details concerning them:

a. Nice, August 5, 1881 (type of *Paradoxichthys Garibaldianus*): Total length, 199 mm. D. 32/0; A. 38/100; P. 9-10; V. 1-10; C. 4?. This specimen has a long, straight spine, pointed backwards, above the maxillary bone on either side.

b. Nice, March 1, 1891: Total length, 186 mm; D. 30/1; A. 41/150; P. 10; V. 1/10; C. 4?. Found dead and partly decomposed. The peculiar maxillary spine is small in this and in the following specimen.

c. Nice, January 27, 1892: Total length, 160 mm. D. 30/0; A. 34/;? Found partially digested in the stomach of *Galeus canis*.

In addition to these specimens one other was taken by the French expedition off the coast of Morocco, station 40, at a depth of 2,212 meters. Its radial formula was D. 37/1; A. 27/?.

MACDONALDIA, new genus.

Notacanthids, with elongate body and inferior mouth. Body and head covered with minute, imbricated scales. Dorsal fin represented by numerous short, straight, robust, and disjoined spines, 27 to 34 in number, the first in advance of the insertion of the pectoral. Anal as in *Notacanthus* but lower, and with a longer portion of low, short, slightly curved, disjoined spines, from 35 to 55 in number, which under the final dorsal spines pass into flexible rays. Lateral line straight, conspicuous. Pectorals moderate, placed far back, below the middle line of the body and remote from the lateral line. Teeth in jaws erect, small; and also in series on the vomer and palate. A line of pores on the inner edge of the mandible. Ventrals moderate, entirely separate. Type, *Notacanthus rostratus*, Collett.

This genus is named in honor of Col. Marshall McDonald, U. S. Commissioner of Fisheries, in commemoration of his liberal policy in furthering ichthyological research.

MACDONALDIA ROSTRATA (Collett) Goode and Bean.

Plate XVIII, fig. 2.

Notacanthus rostratus, Collet, Bull. Soc. Zool. France, 1889, p. 307.

The body is greatly compressed, its outlines tapering rapidly in both directions from the origin of the vent. Its greatest height is con-

tained 3½ times in the distance of the vent from the tip of the snout, or about four-fifths the length of the head, which is contained 9½ times in the total. The snout is compressed, pointed, snake-like, produced beyond the mouth a distance less than the diameter of the eye, and contained three times in the length of the head. The mouth is small; its cleft scarcely reaches to the anterior nostril. Each jaw is armed with a series of minute teet hand a similar series on vomer and palate. The eye is moderate in size, placed not far from the dorsal profile, distant about 2½ diameters from the end of the snout, more than three times from the end of the opercle. Gill opening wide. The body and head covered by minute, imbricated scales. A line of mucous pores extends from the anterior end of the lateral line forward under the eye and thence to the end of the maxilla.

The dorsal spines are short, distant from one another, the first being over the end of the opercle, the fifth slightly behind the vertical through the origin of the pectoral, the twelfth slightly in advance of the origin of the pectoral, the fifteenth almost over the origin of the anal, and the last (twenty-eighth) a little behind the middle of the length of the tail. In another individual the fourth spine is immediately over the pectoral insertion, the thirteenth over the ventral origin, and the whole number of spines is 30, but there is behind the thirtieth a minute spine almost united by membrane. The anal begins immediately behind the vent, and after the fifth spine the height of the fin remains uniform until the length of the rays gradually decreases near the tip of the tail. The pectoral is inserted at a distance from the gill opening nearly twice its own length. The ventrals have a broad base, are not confluent and reach to the vent or slightly beyond it.

D. XXVIII–XXXI; A. XLII–LIII.

The types are No. 35601, U.S.N.M., and were obtained by the steamer *Albatross* at station 2216, latitude 39° 47′ N., longitude 70° 30′ 30″ W., in a depth of 963 fathoms. They measure 16½ and 16 inches, respectively. Another specimen, 17 inches long, was obtained by the same steamer at station 2553, latitude 39° 48′ N., longitude 70° 36′ W., in a depth of 551 fathoms.

Closely allied to *M. rostrata* is *Notacanthus challengeri* (Vaillant) (*Notacanthus rissoanus*, Günther, *Challenger* Report, XXII, 250, pl. LXI, Fig. B: not Filippi and Verany), renamed by Vaillant in the report of the *Travailleur* and *Talisman*, page 387. This is distinguished by the larger number of its dorsal rays, the less anterior position of the origin of the dorsal, the lesser height of the body in comparison with the distance from the vent to the snout, comparatively longer snout and larger eye, and the absence of the suborbital row of mucous pores.

Dr. Günther states that although the species is a matter of some certainty, the diagnosis of *N. rissoanus* "applies sufficiently well to his specimen;" further remarking that "since a number of Mediterranean fishes are identical with Japanese, and at least one other species

of *Notacanthus*, *N. bonapartii*, shows a wide geographical range, he should not feel justified in giving a distinct name to the fish described." We can not help feeling that Dr. Günther has departed from his customary cautious and scientific method in this case, and are satisfied that he would not have done so had he seen the specimen obtained by the French Exploring Expedition on the coast of Morocco, and described and figured by Vaillant. Coming as it does from the Mediterranean region, and having a proboscis-like character of the snout, much more emphasized than in the Japanese form, the presumptions in favor of its identity with *N. rissoanus* are very strong. We therefore not only adopt the identification of Vaillant, in preference to that of Günther, but accept the new name which Vaillant has proposed for the Japanese form.

Family LIPOGENYIDÆ.

Lipogenyidæ, Gill, MS.

Heteromes with a roundish, inferior, suctorial mouth; imperfect lower jaw with its rami separated at middle, connected with the corresponding sides of the upper jaw, and invested in a thick, transversely plicated horseshoe-shaped lip, reflected upward behind on the cheeks; no teeth; short row of four or five partially connected graduated dorsal spines, and five to seven branched rays, forming a regular fin. (Gill.)

The anomalous and unexampled modification of the lower jaw and mouth deserves a detailed anatomical examination; but the existence of only one specimen for the present, at least, is deemed to render such an investigation inadvisable.

LIPOGENYS, new genus.

Head and body compressed, the body elongate as in *Notacanthus*. Snout produced, compressed, obtuse at tip. Cleft of the mouth inferior, suctorial, circular in front, surrounded by rugose, contractile lip, with cleft posteriorly flanked by wing-like flaps, containing the modified mandibulary bones which articulate with the end of the maxilla, and are free behind. A concealed spine at the end of the maxilla. No teeth. Anterior nostril in short tube, the posterior oblong, under a short flap. Dorsal fin short, but normal and well developed, with a distinct soft portion. Anal fin normal in position, high, with many spines, and with some of the rays spine-like, though forked. A distinct though very small caudal fin. Ventrals normal, well developed, with several spines. Scales minute, very numerous. Lateral line conspicuous.

LIPOGENYS GILLII, new species.

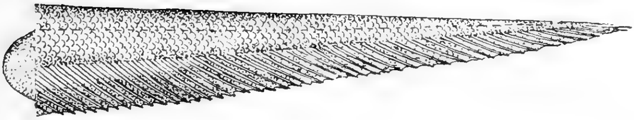
Plate XVIII, fig. 3.

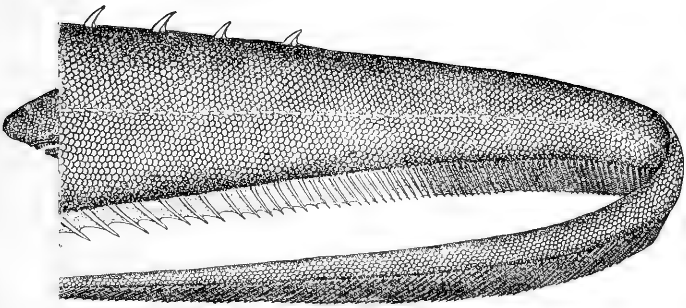
Body compressed, its greatest width one-half its height, which is about one-tenth of the length. The length of the head is contained $8\frac{2}{3}$ times in that of the body and twice in the distance from the origin

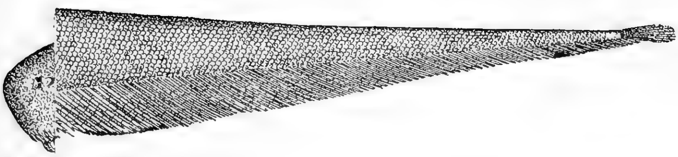
of the pectoral to the vent. The width of the interorbital space is about equal to the diameter of the eye, which is one-fifth the length of the head. The length of the snout is about one-fourth that of the head. The postorbital portion of the head is twice as long as the snout. The peculiar form of the jaws and mouth has been described under the head of the genus. The diameter of the circular opening is about one half the diameter of the eye. The dorsal fin begins at a distance from the snout equal to about three times the length of the head. It consists of five graduated spines, of which the first is minute and the longest as long as the snout, and five rays, of which the second is longest, nearly one-half as long as the head. The spines and rays are all compactly arranged in a strong triangular fin. The length of the dorsal base equals one-half that of the head. The anal begins under the fourth spine of the dorsal; it contains 41 spines and 88 rays, of which the anterior 10 are stiff, though articulated, and divided at the tip. The longest ray is longer than the longest spine, about as long as the snout. The ventral consists of seven spines and seven rays. The two fins almost meet in the median line, but are disconnected. The fin reaches to the vent. Its distance from the tip of the snout is about $2\frac{1}{2}$ times the length of the head. The pectoral is placed below the median line of the body, at a distance from the head about equal to the diameter of the eye; its length is a little greater than the postorbital part of the head. The lateral line is well developed anteriorly, becoming obsolete at a distance from the end of the dorsal about equal to $2\frac{1}{2}$ times the length of the head.

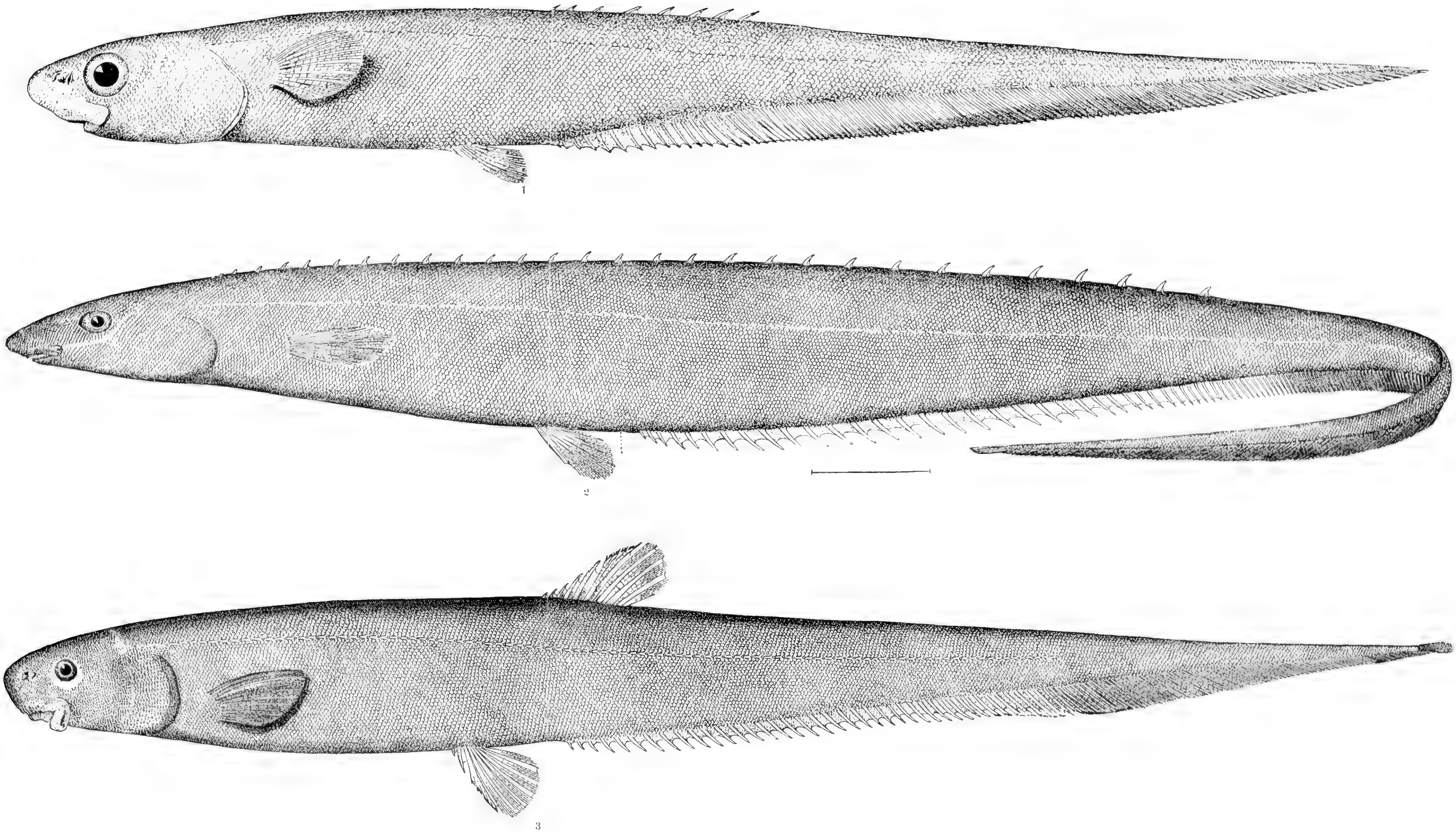
The color is uniform light brown. The under side of the gill covers dark, showing dark at the edges of the opercular bone.

The type measures 17 inches in length. It is No. 39212, U.S.N.M., and was taken by the steamer *Albatross* at station 2742, in N. lat. 37° 46′ 30″; W. lon. 73° 56′ 30″, from a depth of 865 fathoms.









GENERIC TYPES OF MACDONALDIA AND LIPOGENYS.

Fig. 1. *Gigliolia moseleyi*, Goode and Bean.
Fig. 2. *Macdonaldia rostrata*, Goode and Bean.
Fig. 3. *Lipogenys gillii*, Goode and Bean.

SCIENTIFIC RESULTS OF EXPLORATION BY THE U. S. FISH COMMISSON STEAMER ALBATROSS.

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No. XXX.—ON HARRIOTTA, A NEW TYPE OF CHIMÆROID FISH FROM THE DEEPER WATERS OF THE NORTHWESTERN ATLANTIC.

By G. BROWN GOODE and TARLETON H. BEAN.

A REMARKABLE type of Chimæroid fish was obtained by the U. S. Fish Commission steamer *Albatross* while engaged in deep-sea exploration in the northwestern Atlantic.

Four specimens were taken, two of them young, and with proportions quite unlike those of the adults.

The limits of range are, of course, by no means determined by the capture of these isolated specimens, all of which came from between latitudes north 36° 45′ and 39° 44′, and longitudes west 70° 30′ and 74° 28′, each specimen being from a distinct locality. The habitat of the genus must then be described as western North Atlantic, 707 to 1,080 fathoms, off the coasts of Virginia, Maryland, and Delaware.

In the present notice no attempt is made to discuss the relationships of the new form, except to say that it is allied to *Chimæra*, *Hydrolagus*, and *Callorhynchus*. Dr. Gill is disposed to form a subfamily of the Chimæridæ for its reception, and it is not unlikely that as a result of more thorough study it may be found necessary to place it in a family by itself. The descriptive notes which follow are from the advance sheets of our memoir, entitled "Oceanic Ichthyology," and were prepared six years ago. Fearing still further delay in the publication of our book, we present them, together with figures of both old and young.

HARRIOTTA, new genus.

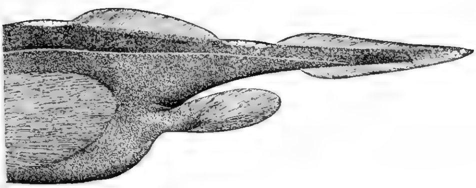
Snout exceedingly elongate, with a cartilaginous midrib and foliaceous lateral expansions of the skin at its base. Two dorsal fins, the anterior with an immense triangular spine, finely serrated upon its lateral edges. Anal fin reduced to a cutaneous fold. Longitudinal axis of the tail nearly the same as that of the trunk, very elongate, with

filamentous tip, the fin below much more extensive than that above. No cephalic organ. Gill-openings lateral; separated by a wide isthmus. No spiracles. Teeth as in *Chimæra*. Claspers small and simple.

HARRIOTTA RALEIGHANA, new species.

Plate XIX.

Tail extended in a very long filament in the older individuals, wanting in the young. The first dorsal fin separated from the second by an interval nearly equal to the diameter of the eye in the older individuals, very much greater in the younger ones, in which the cartilaginous portion is exceedingly narrow and high. The second dorsal fin long and low, its height about equal to the diameter of the eye, its length equal to that of the head. The spine preceding the first dorsal fin is very strong; its length in the older individuals equal to the distance from its own base to the origin of the second dorsal; it is proportionately much longer and stouter in the young, and there is also a double row of strong spines in advance of the second dorsal, and in the notch between the second dorsal and its continuation upon the upper part of the tail; and there is also a similar group of at least six strong spines upon the top of the head back of the interorbital space, and surrounded by the curve of the forward extension of the lateral line. Faces of these spines may be felt beneath the skin in older individuals of both sexes. Claspers in the young male examined, small and simple, in length scarcely equal to two-thirds of the long diameter of the eye. Pectoral fins immense, wing-like, rounded in the young, subfalcate in the older individuals; inserted slightly in advance of the origin of the first dorsal, and extending in the older forms beyond the root of the ventral. Ventrals also subfalcate; similar in form and appearance to the pectoral, and extending to a point at two-thirds of the distance from the origin to the end of the second dorsal; in length little less than half the snout. In the young, the ventrals are placed somewhat farther back, and reach to a point under the origin of the third section of the dorsal fin. The tail is prolonged in a slender filament, and in the older individuals the cutaneous flap upon its lower edge is three or four times as deep as that above, and extends beyond it anteriorly and posteriorly. In the younger specimens the upper and lower flaps are about equal in height, and the upper flap extends far in advance of the insertion of the lower one. The lateral line extends in a straight line from a point beneath the origin of the first dorsal approximately to the middle of the lower caudal lobe, which it follows along its base for the remainder of its course; in advance of the dorsal fin it bends downward in an elliptical curve, and then rises vertically from the occiput to join its counterpart from the other side; bridle-like extensions of the same system extend on the sides of the head under the eye, curving upward in front of the eye, then downward and joining on the under side of the snout to a branch running from beneath the eye downward to the base of the



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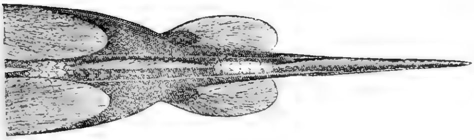

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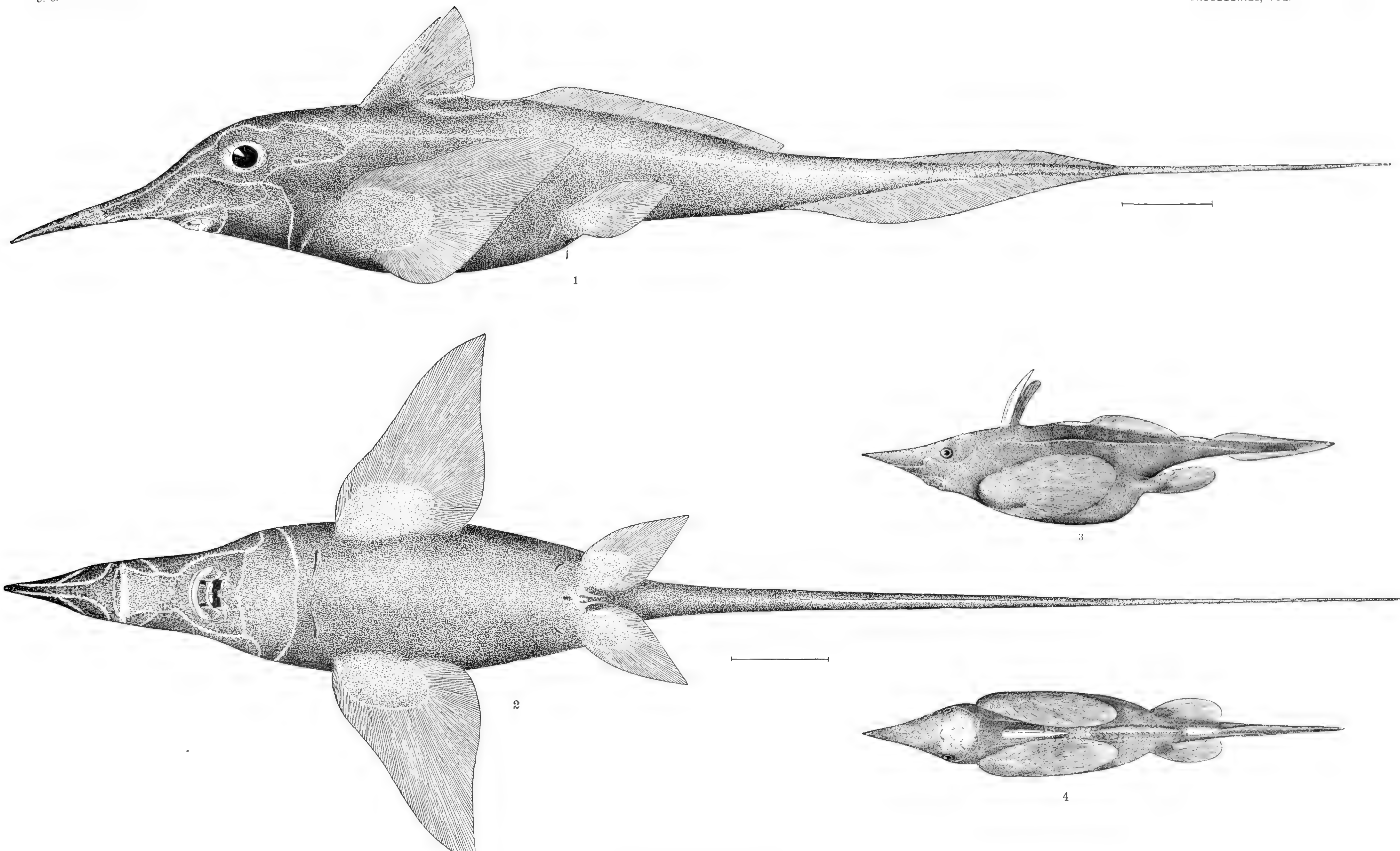

NEW SPECIES OF HARRIOTTA.

Figs. 1, 2. *Harriotta raleighana*, Goode and Bean. (Adult.)
Figs. 3, 4. *Harriotta raleighana*, Goode and Bean. (Young.)

pectoral fin in the young, or under the throat to a junction in the older ones, and also forward from the same point under the eye to join on either side the circle which surrounds the mouth. An elaborate system of mucous pores upon all sides of the snout; on the under surface of the snout in four longitudinal series. In the older individuals there is an extension of the lateral line system on either side of the midrib on the snout to its tip, and there are also symmetrical continuations of the same upon the under surface of the snout. Color, brown; caudal filament, pale.

The diameter of the eye is contained $5\frac{1}{2}$ times in length of the snout in the older specimens, and the distance between the eyes is equal to their diameter.

Of this species we have seen four specimens: The largest, a female (No. 39415, U.S.N.M.), 25 inches in length, from 39° 44′ 30″ N. lat., 70° 30′ 45″ W. long., in 1,081 fathoms, taken by the steamer *Albatross*. Another, a male (No. 38200, U.S.N.M.), $19\frac{1}{2}$ inches in length, was taken by the *Albatross* in 36° 45′ N. lat., 74° 28′ 30″ W. long., at a depth of 781 fathoms. A third, a young individual (No. 25520, U.S.N.M.), 4 inches in length, was obtained by the *Albatross* in 39° 37′ 45″ N. lat., 71° 18′ 45″ W. long., in 991 fathoms. Still another, No. 35631, was taken at station 2235, lat. 39° 12′, long. 72° 03′ 30″, in 707 fathoms.

This species is named in honor of Sir Walter Raleigh, philosopher and explorer, by whom the first English scientific expedition was sent to the New World.

OVERLAYING WITH COPPER BY THE AMERICAN ABORIGINES.

By Otis T. Mason,
Curator of the Department of Ethnology

In a recent paper* Prof. F. W. Putnam gives an account, with figures, of several objects made of wood and covered with copper. In a later report † is an account of copper objects sheathed with silver, a pendant of copper sheathed with gold, ear ornaments of copper sheathed with silver and meteoric iron, and bracelets of copper sheathed with silver. Since that time Prof. Putnam has found many other specimens from Ohio, and calls attention to Atwater's statement, in Archæologia Americana, describing objects as being overlaid with silver.

Numerous specimens have been discovered by others, notably by Mr. Warren K. Moorehead, in his explorations of mounds near Chillicothe, Ohio. These examples are quite sufficient to show that the American aborigines in the Mississippi valley and in South America had the art of cold-hammering copper, of beating it to overlie and fit upon a warped or curved surface, and of turning the edges under.

This process must not be confounded with the mere hammering out of implements, nor with that other process of making a sheet of copper as thin and uniform as a ship's sheathing and then producing figures by rubbing or pressure. Some doubt had been expressed concerning the genuineness of such work, but Mr. Cushing's late experiments‡ change the status of the problem. But of the overlaying and turning under there can be no reasonable doubt. It is entirely within the compass of tools known to have been used. That there might be no mistake about this, Mr. Joseph D. McGuire has hammered out a nugget of Lake Superior copper into a sheet as thin as the one figured, and by grinding the surface with common sand has removed all marks of the stone hammer and stone anvil. These experiments were conducted in the National Museum by the simplest processes. No attempts were made to do the overlaying. This is to be regretted, as the warping of the sheet so as to lie close to the uneven surface must have required great skill.

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* Report of the Peabody Museum, Cambridge, Mass., 1881.

† *Op. cit.*, 1883, p. 171.

‡ Am. Anthropologist, I, 1894.

To compare with the overlaying of wood and bone by sheet copper, discovered in the mounds and described by Putnam, the U. S. National Museum has received from Lieut. G. T. Emmons, U. S. Navy., two figures of humming birds in wood, well carved and painted red. Illustrations of these are given below. Each wing and the tail of each bird is overlaid with a covering of sheet copper, pressed down to fit and turned under at the margins so as to be held fast. The surfaces are adorned with the conventional wing and eye signs of the Haidas. Especial attention is called to the carving on the copper. The furrows and ridges are all cut with steel tools. The effects are produced by first making a narrow, deep furrow and then scraping the metal away from one edge.

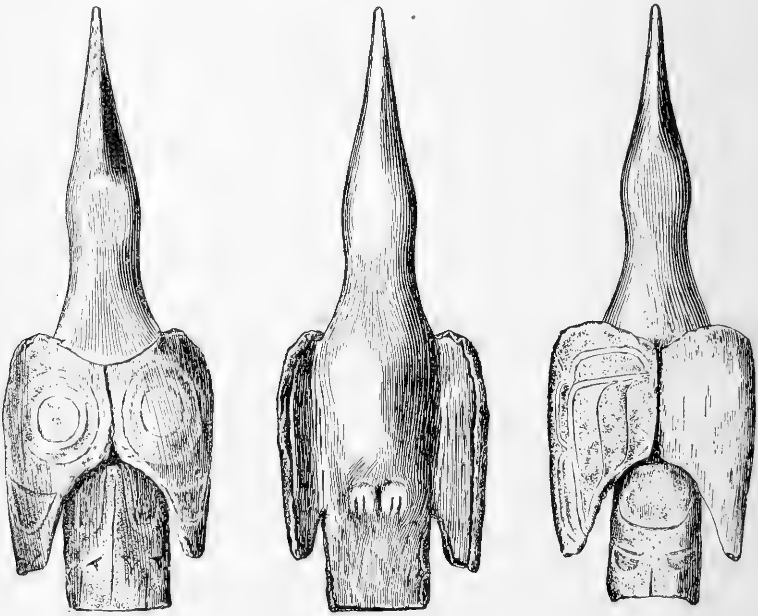

Fig. 1. Fig. 2. Fig. 3.

BIRDS OF WOOD, WITH WINGS AND TAIL OVERLAID WITH COPPER.

Metal working by the American aborigines.

The author does not remember whether any engraving appears on the Ohio mound specimens. Such as the Haidas and the Tlingets now make with jewelers' tools would have been above and beyond the ability of the aboriginal metallurgists of the Mississippi valley.

Figure 1 shows the first example of a bird (No. 165,677, U.S.N.M.) neatly carved from wood. The work has been very cleverly done, and the specimen gives evidence of having been used for a long time. The tail and each wing are separately overlaid with a sheet of copper, closely fitting. The ornamentation upon the surfaces are the abbreviated symbols for eyes and wings. Figure 2 represents the under side

of the same object and exhibits more graphically the manner in which the edges of the copper plates are thinned out and turned under all round to prevent their falling off.

Figure 3 shows the second bird with one wing cover removed. Here is to be observed the careful manner in which the upper surface of the wing was carved to shape and smoothed down. The copper plate is warped so as to lie in contact with this surface at every point. The removal of the plate and the examination of the reverse side, shown in figure 4, reveal the metallurgic processes employed. It will be seen that neither punch nor severe pressure produced the marks on the outer surface. The marks on both examples were cut with metal tools. These specimens have both been examined by a skillful engraver and they have given evidence of having been cut and scraped as indicated above.

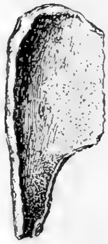

Fig. 4.

COPPER WING COVER.

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

[Published by permission of Hon. Marshall McDonald, Commissioner of Fisheries.]

No. XXXI.—DESCRIPTIONS OF NEW GENERA AND SPECIES OF CRABS OF THE FAMILY LITHODIDÆ, WITH NOTES ON THE YOUNG OF LITHODES CAMTSCHATICUS AND LITHODES BREVIPES.

By James E. Benedict,

Assistant Curator, Department of Marine Invertebrates.

Crustacea of the convenient suborder of Decapoda known as Anomura, from the North Pacific Ocean and Bering Sea, a region prolific in representatives of this group, have been gradually accumulating in the Museum. Recently large collections have been received from the U. S. Fish Commission from dredgings made by the steamer *Albatross* in Bering Sea and on the voyage to and from that locality. In these collections are many fine specimens of the family *Lithodidæ*, which contains the largest of known crabs, with the exception of the giant maioid crab of Japan, *Macrocheira kaempferi* of de Haan. Though the following descriptions and notes are based principally on Fish Commission material from the above region, one species of *Lithodes* is described from the North Atlantic and one from the South Pacific.

LITHODES GOODEI, new species.

Lithodes agassizii, Smith (part), Bull. Mus. Comp. Zool., x, p. 8 (part), pl. i, figs. 2 and 2*a*, 1882; Proc. U. S. Nat. Mus., vi, 1883, p. 25 (part); Rept. Comr. of Fish and Fisheries, 1882, p. 351 (1884); Rept. Comr. of Fish and Fisheries, 1885, p. 607 [3], p. 638 [34], pl. iii, figs. 1 and 2 (1886).—Verrill, Rept. Comr. of Fish and Fisheries, 1883, pp. 521, 553 (part), pl. xxxiii, figs. 151*a*, 151*b* (1887).

An examination of the specimens of *Lithodes* taken by the *Albatross* in deep water off the eastern coast of the United States, shows a wide difference between those from south of Cape Hatteras and those from more northern waters. The average range in depth of the northern form is about 900 fathoms, of the southern 500 fathoms. The southern form, *Lithodes agassizii*, was described by Prof. S. I. Smith from the dredgings of the *Blake*.* Prof. Smith also describes and figures in the same place the young of the northern form as the young of *L. agassizii*.

* Bulletin of the Museum of Comparative Zoology, x, p. 8.

A series of specimens from both localities convinces me that the two forms constitute good species.

These two species and the species described next in order constitute a group having in common a rostrum with a long median spine and two basal spines and lacking the subrostral spine or horn usual in the genus.

The carapace of *L. goodei* is much more convex than that of *L. agassizii.* The spines arise from the summit of large tubercles, and the surface altogether lacks the small spines so thickly sprinkled over the latter species. The spines of the rostrum like those of the carapace are much longer than those of *L. agassizii*, and while the horn is wanting, its position is indicated by a slight protuberance. The antennal scale is rudimentary, with the exception of a specimen from station 2203 on which it is rudimentary on the left side and well developed on the right.

On the second segment of the female abdomen there are about twelve spines ranging in length from 12 to 20 mm. The large plates on the left side of the abdomen are but little calcified in *L. agassizii;* in *L. goodei*, they are much more firm. The conical tubercles are also better calcified and fewer in number on the leathery portion.

Another marked difference between the two species lies in the very much longer spines of the chelipeds and ambulatory legs. In the adult specimen before me from station 2193, several spines on the carpal and propodal joints reach the great length of 43 mm.; on another specimen they are but 30 mm. In our largest specimen of *L. agassizii* the spines on these segments measure but five or six mm. A no less striking difference is seen in comparing the ambulatory legs of the two species, the subcylindrical legs of *L. goodei* contrasting with the flattened legs of *L. agassizii*, the former free from spinules between the spines and the latter thickly sprinkled with them.

Young: In *L. goodei* the variation in length of spines from the young to the adult is extreme. In a young specimen 70 mm. in length the length of one of the spines at the base of the rostrum is 44 mm.; the spines of the carapace are from 32 to 38 mm. in length.

Type.—No. 8047, U.S.N.M.; female; off Nantucket Shoals; station 2196; 1,230 fathoms.

LITHODES DIOMEDEÆ, new species.

This species is very close to *L. goodei*, but it is not difficult to separate the two. Good specimens were obtained by the *Albatross* from station 2789, off the southern part of Chile, in latitude 42° 36′ S., No. 18526, U.S.N.M. Numerous young *Lithodes* taken at station 2788, in latitude 45° 35′ S., No. 18527, U.S.N.M., I have also referred to this species.

The spines of the carapace are not so long as those of *L. goodei*, but are more slender and similarly placed; their tubercular bases are not

so large and swollen as in the Atlantic species. The rostrum is of the same character as in *L. goodei*. The chelipeds are much the same, but the fingers are a little more slender and the tubercles on the prehensile edges of the right hand are much smaller. The ambulatory feet have a few spines twelve mm. in length on the carpal and propodal segments. One of the largest spines of the ambulatory feet projects from the ischium, while the spines of the coxal joints alone are sufficient to distinguish this species from any other species of *Lithodes* that I have seen. These spines project from the distal lower margin and vary from eight to eleven mm. in length.

The numerous young taken at station 2788 are similar to the adult, except that where spines are barely indicated in the adult there are short sharp spines in the young.

LITHODES ÆQUISPINUS, new species.

Carapace, rostrum, chelipeds, and ambulatory legs with conical spines subequal in length. The range in length is from about four to six mm. The longest spines of the carapace are scattered along the lateral margins; the longest spines of the cheliped are at the inner distal margin of the merus and the spines on the middle point of the inner margin of the carpal segment. The areolations of the carapace are well marked, but not so bold as in some species. The rostrum is on a line continuous with the gastric region, and consequently a little depressed. A line of seven spines runs along the median line of the gastric region to near the bifurcate tip of the rostrum. The two spines on the rostrum are larger than those of the gastric region. The rostrum is armed with nine spines, arranged as follows: Two on each side, two above, two at the end forming the bifurcate tip, and the lower spine or horn, which is the largest spine on the species.

Locality.—Bering Sea, stations 3332, 3489, and 3502; 184 to 406 fathoms.

Type.—No. 18528, U.S.N.M.; station 3332; 406 fathoms.

LITHODES COUESI, new species.

This species reminds one of *L. maia*. The largest spines of the carapace are arranged about the margin; they are slender and sharp. The longest are situated at the outer orbital angles, the antennal angles, the hepatic regions, and three on the margin of the branchial regions. The spines on the intervening spaces of the margin are more numerous and much smaller. The surface of the carapace is set with short, sharp, conical spines. The gastric region is swollen and well defined. The cardiac region is barely indicated between the confluent branchial regions. The depression between the gastric and cardiac regions is very deep. The rostrum is 20 mm. long, and made up as in *L. maia*, but the terminal portion beyond the distal lateral branches is slender and bifid rather than bifurcate, as in *L. maia*; the basal branches are

a little further forward. The scale is rudimentary; the spine at the outer angle is branched at the base, the branch consisting of a single short, sharp spine on the outer surface. The abdomen is without spines; the spines of *L. maia* are replaced by tubercles; those of the first segment are very much closer together than the corresponding spines in *L. maia*. The tubercles on the lower margin of the second segment are low and somewhat oblong at base; those in the center of the segment are larger.

The chelipeds are slender and weak. The armature of the fingers of the right hand is slight; the fingers gape. The fingers of the left hand are long and slender and gape at base. The spines of the chelipeds and ambulatory legs are numerous and arranged about as in *L. maia*, but are shorter.

Locality and type.—At station 3329, in 399 fathoms, north of Unalaska, a single male (No. 18531, U.S.N.M.) was taken; also at station 3338, off Shumagin Bank, in 625 fathoms, three young specimens (No. 18532, U.S.N.M.) which I refer to this species without hesitation. The rostrum differs in being bifurcate as in *L. maia*. It is possible that additional specimens of the adult form might show the rostrum to be bifurcate rather than bifid.

LITHODES RATHBUNI, new species.

Carapace of male armed with long spines on the different regions; also with longer spines on the margins. There are four on the gastric; two short and two long on the cardiac region. The branchial region has six spines of various lengths. The postero-lateral margin has the longest spine, it being 26 mm. in length on one side and 23 mm. on the other. Both have lost their points. Anterior to this there are three spines, the shortest unbroken one being 17 mm. long; on the margin posterior to the longest spine there are four spines, the longest of which is 14 mm. in length and the shortest eight mm. The rostrum is composed of five branches; the main stem is sharply bent upward and is strongly bifurcate; the lower horn is almost on the horizontal line of the body, and projects forward more like the usual main portion of the rostrum; the lateral branches arise at the base and project forward. The movable spine of the antenna is very long and slender; there is a short branch or spine on its outer and upper margin near the base.

The right cheliped is slender and rather weak. Its longest spine is situated on the distal upper margin of the merus. There are upwards of twelve spines on the carpus. On the median outer surface of the palm there are two rows of four spines each. The fingers gape at the base; their prehensile edges are tubercular. The left cheliped is smaller and more slender than the right. The cutting edges of the fingers run back to the gape, or a little more than one-half their length. The ambulatory legs are slender and very spiny; the spines are from three to five mm. in length.

Locality.—Station 3191, off San Simeon Bay, California, in 211 fathoms.

Type.—No. 18533, U.S.N.M.

LITHODES CALIFORNIENSIS, new species.

This species is remarkably like the preceding, except in the relative length of its spines and the form of the rostrum. It comes from about 100 miles farther south. There are two specimens, both females, while the only representative of the preceding species is a male. As the differences between them are not known to be sexual, I hesitate to unite them.

The spines of the carapace are much shorter and stouter, but occupy the same relative position. On the lateral margin there are two long spines; the one above the third ambulatory foot equals in length, but is much stouter, than the one similarly placed on the preceding species. The most marked difference between the two species is in the rostrum; in both specimens of *L. californiensis* the rostrum is bifid, while in *L. rathbuni* it is bifurcate, the tip being composed of two well-developed divergent horns. The subrostral spine extends out almost as far as the rostrum proper. The chelipeds are as in *L. rathbuni*, except that the spines are shorter and there is less gape in the right hand and more in the left.

Locality.—Station 2949, off Santa Cruz Island, California, in 155 fathoms.

Type.—No. 18534, U.S.N.M.

LITHODES CAMTSCHATICUS (Tilesius).

Maja camtschatica, TILESIUS, Mem. Acad. Imp. Sci., St. Petersburg, v, 1812, p. 336, pls. v and vi (1815).

Lithodes camtschaticus, LATREILLE in Cuvier's Règne Animal, 2d ed., iv, p. 65.

Lithodes spinosissimus, BRANDT, Bull. Phys. Math. Acad., St. Petersburg, vii, 1849, p. 172 (Young).—STIMPSON, Boston Jour. Nat. Hist., vi, p. 478, 1857.

The measurements and description of *L. spinosissimus* given by Brandt indicate that the thorax sent him by Wosnessenski was that of a young specimen of *Lithodes*. The Alaskan collections contain many young *Lithodes* that come well under Brandt's short description, except that the rostrum proper is bifid, while Brandt describes it as simple. One specimen from a lot taken at station 3233, 7¼ fathoms, Bristol Bay, answers his description in this respect. I believe this specimen to be abnormal, as the other young from the same station have the bifid rostrum. The spines on the carapace of the young are placed as in the adult, but are proportionally much longer. A large amount of dredging has been done in Alaskan waters, and nothing that I have seen approaches the description of *L. spinosissimus* except the young *Lithodes* which I have confidently referred to *L. camtschaticus*.

LITHODES BREVIPES, Milne-Edwards and Lucas.

Lithodes brevipes, MILNE-EDWARDS and LUCAS, Arch. Mus. Hist. Nat., Paris, II, p. 465, pls. XXIV-XXVII, 1841.

Lithodes camtschaticus, RICHTERS, Abh. Senck. Natur. Ges., XIII, p. 404, figs. 9 and 10.

In the work cited Dr. Richters describes and figures young *Lithodes* as the young of *L. camtschaticus*. There are four specimens of the same form in the collection; one obtained by Mr. William Palmer at St. Paul Island, where Dr. Richters' specimens were collected; two by Dr. L. Stejneger at Bering Island, and one dredged by the *Albatross* at station 3558 in 25 fathoms. The largest specimen is a cast shell washed up by the tide; it is 34 mm. in length and 31 mm. in width. The smallest specimen is 16 mm. in length by 14 mm. in width. In most respects the largest of the young is a miniature of the adult *L. brevipes*, but contrary to the rule in seven species of *Lithodes* the young of which are in the collection, the young of *L. brevipes*, if I have not mistaken it, have but a bare indication of spines, or rather of the place where spines are to be, the spines being indicated on the carapace of the smallest by small granules better seen with a lens, while in the largest specimen the spines are indicated by tubercles, and at the summit of the tubercles there is not the slightest indication of the sharp, horny-tipped spine of the adult *L. brevipes*. The movable antennal spine of the adult is bifurcate; in the young it is bifid.

LEPTOLITHODES, new genus.

Paralomis (part), HENDERSON, Challenger Report, XXVII, p. 44, 1888. Not *Paralomis*, WHITE and STIMPSON.

White established the genus *Paralomis* in 1856 by thus designating *Lithodes granulatus* of Hombron and Jacquinot. An examination of a single specimen of that species from Sandy Point, Straits of Magellan, shows it to belong to White's previously established genus *Echinocerus*. The name *Paralomis* as a synonym of *Echinocerus* being no longer available, I propose the name *Leptolithodes* for those species having long and angular ambulatory legs and comparatively stout chelipeds. The species of the genus will then be as follows, in the order of description: *Leptolithodes aculeatus* (Henderson), *L. asper* (Faxon), *L. longipes* (Faxon), and the two species here described from the west coast of the United States and British Columbia.

LEPTOLITHODES MULTISPINUS, new species.

The carapace is about as broad as long; the areolations are well defined On the median line at the summit of the gastric region there is a sharp spine about four mm. in length. The lateral margins are armed with from twelve to sixteen spines about three mm. in length. In the young and in some of the adults there are small spines on the branchial region. A semicircular line of six or seven spines marks the

limits of the branchial and intestinal regions. The carapace is thickly studded with blunt spines, each terminating in a flattened face or surface cut obliquely to the surface of the carapace; this face is encircled by a fringe of short stiff bristles. The rostrum consists of a simple median spine with two basal spines. Under the rostrum proper there is a very short conical spine homologous with the subrostral spine of *Lithodes;* behind the spine are one or more spinules. The abdomen in the male is composed, after the second segment, of several rows of leathery plates; the second segment is better calcified and harder. The abdomen of the female is twisted to the right as in *Lithodes*.

The chelipeds are moderately slender and extend almost to the distal end of the carpal joints. The spines on the inner margin of the carpal segments are the most prominent. The ambulatory legs are long and slender and thickly set with spines. The spines of the merus are not so distinctly arranged in rows as on the carpal and propodal segments; there is, however, a distinct row on the upper margin. The spines of the carpus are arranged in eight more or less distinct rows; on the propodal segment the spines are arranged in six full rows and two half rows. There are four short rows of spines on the proximal end of the dactylus. The dactyli are compressed, slightly bent and a little twisted. An average-sized specimen measures 80 mm. in length, 78 mm. in breadth, and the distance from tip to tip of the ambulatory legs is 360 mm.

Types.—No. 18535, U.S.N.M., off Queen Charlotte Islands, British Columbia, station 2860, 876 fathoms.

LEPTOLITHODES PAPILLATUS, new species.

From the *Albatross* dredgings off Lower California, or perhaps south of that region, there is a male specimen of *Leptolithodes* without a label. It is much larger than any other species in the collection, and while differing materially is yet very closely related.

The carapace is broader than long; the areolations are well marked. The gastric region has no spine, and is not protuberant as in *L. multispinus*. The cardiac region is much shorter; the depressions run into one which extends to the margin of the carapace at the middle of the posterior border. In *L. multispinus* the grooves run separately back to the posterior border, with the posterior point of the cardiac region between them. There are no spines on the dorsal surface or margin of the carapace; even the anterior angles lack spines. From the spines at the external orbital openings to the posterior margin there are small tubercles or papillæ on the margin. In the center of some of these tubercles by the aid of a lens a very small horny point can be seen surrounded by bristles. The surface of the carapace is thickly set with these small papillæ which bear stiff setæ irregularly scattered over the summit. In *L. asper* (Faxon),* the papillæ are encircled with a crown of stiff setæ.

* Bull. Mus. Comp. Zool., XXIV, p. 164, 1893.

The rostrum is simple with two very small basal spines. Beneath the rostral spine there is a swelling where in *L. multispinus* there is a short spine. The eyes extend far beyond the basal spines of the rostrum, while in *L. multispinus* the spines extend much beyond the eyes.

The chelipeds are much stouter than those of *L. multispinus*, and the fingers of both hands are more curved.

The ambulatory legs are similar to those of *L. multispinus*, but the spines are not so long and are broad at the base; the dactyli are comparatively shorter, stouter, and broader at the tips.

Type.—No. 18536, U.S.N.M., off Lower California (?).

PRISTOPUS, new genus.

The rostrum, antennal scale, and the character of the abdomen are substantially as in *Leptolithodes*. The legs are much compressed; the anterior and posterior margins are set with sharp spines. In *Leptolithodes* the legs are angular, not at all compressed, and the spines are arranged in rows on the angles or ridges. *Paralomis formosus*, Henderson, belongs to this genus.

PRISTOPUS VERRILLI, new species.

The carapace is verrucose, the areolations prominent. The gastric region is much elevated and is surmounted by a small spine. On each side, on the border of the branchial region, there is a deep pit. A groove runs from the pits to the depression between the gastric and cardiac regions. There are about twelve spines, two to three mm. in length on the lateral border of the carapace. The posterior boundary of the intestinal region is marked by a semicircular row of tubercles. The cardiac region is triangular; the apex of the triangle cuts well into the intestinal region where the depression that marks it runs into a deep slit or oblong median depression. The frontal margin is broad and straight. The spines of the anterior angles and the orbital spines point forward; the orbital spines are a little the longer. Between the spine on the angle and the orbit there is a row of smaller spines and one or two granules. The trispinose rostrum is composed of a bifurcate rostrum proper and the subrostral spine which extends much beyond the two upper rostral spines. The antennal scale tapers to a sharp point and has three sharp spines or branches on each side. The lateral plates on the left of the abdomen in the female are fringed with short, slender, blunt spines.

The chelipeds extend a little beyond the middle of the propodal segment of the first pair of ambulatory feet. The right cheliped is stouter than the left. The prehensile edges of its fingers are strongly tubercular. The upper margin of the palm is spiny; there are also some small spines on the middle and on the lower margin. There are three long spines on the inner margin of the carpus. The left cheliped is similar but smaller, and the prehensile edges of the fingers are sharp.

The ambulatory feet are wide and much compressed. The anterior and posterior margins are armed with sharp spines, alternating in general large and small. On the upper surface of the proximal end of the merus of the fourth pair of feet there is a row of fine spines; the corresponding spines on the third pair of feet are smaller, and on the second pair still smaller.

Type.—No. 18537, U.S.N.M. Off the Pribylof Islands, Bering Sea, station 3501, 688 fathoms.

ŒDIGNATHUS, new genus.

Similar to *Dermaturus*, but with the terminal joints of the outer maxillipeds much dilated as in *Hapalogaster*. The outer margin of the antennal scale is expanded and thin; the inner margin is concave, giving the scale a half-moon shape.

ŒDIGNATHUS GILLI, new species.

Carapace longer than wide, convex in both directions. The areolations are not well marked but can be made out. There are no spines on the margin behind the antero-lateral angles. The surface is set with flattened plates moderately large, and of a deeper color than the surface; these plates are surrounded by rows of short curled bristles; on the anterior side of the plates are patches of holes larger than those from which the hair arises; they may be the follicle holes caused by some larger form of bristle that has disappeared from the old dry specimens from which this description is written. The lower surface of the broad moon-shaped antennal scale is smooth, the upper surface is rough, the outer edge has three or four short triangular teeth. The spine at the external angle of the orbit is very small; the rostrum is simple, short, and pointed. The distal ends of all the joints of the maxillipeds are swollen, but in the ultimate and penultimate remarkably so. The abdomen is as in *Dermaturus mandti*. The chelipeds are thickly set with granular tubercles. The right one is very large and reaches much beyond the ambulatory feet. The fingers gape widely from the palm to the tips. The left cheliped is much smaller, and the hand in proportion to the large one reminds one of *Gelasimus* among the Brachyura. The fingers are spoon-shaped; they have some very small tubercles on the edge, but the edge for the most part is black horn color. The ambulatory feet are rounded, short, and strong, without spines; the dactyli are compressed and armed with spinules beneath.

Types.—No. 18525, U.S.N.M.; locality unknown, 2 ♂.

Locality.—Alaska, W. H. Dall; one claw, without label, No. 18524, U.S.N.M.

LEPEOPUS, new genus.

Rostrum simple, triangular. Penultimate and ultimate joints of maxillipeds not dilated. Antennal scale short, flattened. Abdomen of female much twisted to the right; first segment very small, second very

large; third, fourth, and fifth segments represented on the left margin by large plates; sixth and seventh segments very small. In the male, the third, fourth, and fifth segments are soft, without plates; the sixth segment is central, and the seventh difficult to distinguish. The chelipeds are subequal, the fingers long and spoon-shaped. The dactyli of the three pairs of ambulatory feet shut against two spines situated on the distal under surface of the propodus, giving the feet a prehensile character.

LEPEOPUS FORCIPATUS, new species.

The carapace is flattened, broader than long; the areolations are but slightly marked. The anterior angles of the carapace are produced to a point reaching much beyond the line of the points of the prominent orbital spines or points. The rostrum is triangular, produced and bent downward. The antennal scale is short, flattened, and squamose. The carapace and abdomen are thickly set with rows of short bristles situated in transverse, straight depressions. The ambulatory legs are also set with rows of short bristles, but the depressions are semicircular and imbricated. These, with the markings of the carapace, give the crab a very squamose appearance. The squamæ of the chelipeds are much smaller and less conspicuous. The chelipeds are not so long as the ambulatory feet, reaching to about the middle of the propodal joints. There are four or five spines on the inner and upper margins of the merus, and one on the inner margin of the carpus. The fingers are long and weak, broadening out into spoon-shaped tips. The outer or contact edges are armed with very small tubercles and bunches of bristles, while the inner edges are armed only with the bristles. The merus of the ambulatory legs is armed on the anterior margin with five or six short conical spines; it is broad and much flattened; its anterior margin is semicircular and its posterior margin straight. The carpus is much narrower than the middle of the merus and is about the same width as the propodus. The propodus has straight margins and is much flattened; on its distal under surface are two spines which receive the dactylus; right behind on the central line is a third sharp spine. The dactyli are short and flattened, terminating in a sharp, spine-like tip; the inner margin is thin and armed with spinules.

I know nothing of the habits of this crab, but from its lightness and soft texture, the shell being calcified merely enough to keep its form, I believe it may be found among seaweed, when its subprehensile ambulatory legs may assist it to hold its position.

Types.—No. 6608, U.S.N.M.; Parry Passage, Graham Island, British Columbia, J. G. Swan; 2 ♂, 1 ♀.

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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No. XXXII.—REPORT ON THE CRUSTACEA OF THE ORDER STOMATOPODA COLLECTED BY THE STEAMER ALBATROSS BETWEEN 1885 AND 1891, AND ON OTHER SPECIMENS IN THE U. S. NATIONAL MUSEUM.

By Robert Payne Bigelow, Ph. D.,

Bruce Fellow in the Johns Hopkins University.

The material which forms the subject of this report is derived from various sources. It consisted at first of the Stomatopoda collected by the *Albatross* on her voyage around to the Pacific during the winter of 1887–'88. This had been referred to Prof. W. K. Brooks for a report, and it was at his request that I undertook the task. Subsequently the later collections of the *Albatross* were turned over to me, including the specimens collected during the expedition of 1891 under the direction of Dr. Alexander Agassiz. The Crustacea of that expedition had been referred to Dr. Walter Faxon, and I am indebted to him for the Stomatopoda. I have had, moreover, free access to the collection of Stomatopoda in the U. S. National Museum, including the earlier collections of the *Albatross*, specimens collected by the U. S. Fish Commission schooner *Grampus*, and specimens sent in by naval officers and others. Many of these specimens had already been identified by Mr. Richard Rathbun. I have been able to make also a small addition to the collection, consisting of four species collected by me in the Bimini Islands, Bahamas, while there, during the summer of 1892, in connection with the marine laboratory of the Johns Hopkins University.

The collection as it now stands before me consists of adults and larvæ, the former representing 34 species, distributed through 5 genera, as follows: *Gonodactylus*, 2; *Odontodactylas*, 2; *Pseudosquilla*, 6; *Lysiosquilla*, 5; and *Squilla*, 19. Of all these 14 are new species. They comprise inhabitants of tropical and temperate waters of both hemispheres. The collection of larvæ is large, but it contains nothing like a complete series of stages of any one species and almost no larva that can be referred with any certainty to its adult form. It does con-

tain, however, a few specimens of unusual interest, which will be described in the concluding section of this report.

As it has not been my intention to expand this report into a monograph of the group, I have gone into the matter of classification only so far as seemed necessary to indicate my views as to the relationships of the species with which I have had to deal. I have not used the comparatively recent classification of Gerstaecker (1889), because it does not seem to me at all satisfactory, but have followed Miers and Brooks, avoiding changes unless there appeared to be strong reasons for making them. In a preliminary paper, however (1893*a*), I pointed out that the species of the genus *Gonodactylus*, as it stood then, fell naturally into two groups, which I ranked provisionally as subgenera, and for one of which I proposed the name *Odontodactylus.* It seems better now to regard them as distinct genera, of which one retains the old name, while the other is described in this report under the new name just mentioned. It is possible that the latter will be found on future investigation to merge into the genus *Coronida*, but they appear to be distinct at present. The genera *Leptosquilla* and *Pterygosquilla* have been inserted in the key to the genera, although there seems to be hardly sufficient ground for separating them from the *Chloridella* section of the genus *Squilla.*

An analytical key is the best form in which to convey a general idea of the distinguishing characters of a group of species, but it can not always be made to show the natural affinities. Nevertheless I have endeavored to do so as far as possible, and with that end in view have rearranged the species of *Lysiosquilla* and *Squilla.* It will be noticed that the principal divisions that I have made in these genera do not correspond with the old divisions into *Lysiosquilla* and *Coronis* on the one hand, nor into *Squilla* and *Chloridella* on the other.

This work has almost all been done in the biological laboratory of the Johns Hopkins University, and I desire to express my thanks to Prof. Brooks for his advice and supervision. I am, however, alone responsible for any errors or omissions that it may contain. I have also to thank Mr. James E. Benedict and Miss Mary J. Rathbun, of the National Museum, for valuable assistance, and Mr. Baldwin for his care in making the greater part of the drawings.

Order STOMATOPODA.

This order may be defined as a group of malacostracous Crustacea in which the stalked eyes and the first pair of antennæ are borne upon distinct movable segments; the rostrum in the adult is separated by a movable joint from the carapace, which is small and does not cover the last four distinct thoracic segments; the first five of the eight pairs of thoracic limbs are not biramous and are adapted to serve as accessory mouth parts, the second pair being strongly developed into the large raptorial

limbs in which, as in the three following pairs, the terminal segment (dactylus) closes upon the next segment (manus) like the blade of a pen-knife; the last three pairs of thoracic limbs are biramous, having a lateral appendage upon the penultimate segment, and are adapted for walking; the abdomen is very strongly developed; tufted gills are carried upon the exopodites of the first five abdominal appendages and the sixth pair (uropods), which act with the telson as a powerful tail fin, are strengthened by a stout process from the basal segment ending in one or two spines.

Family SQUILLIDÆ.

We may regard the *Stomatopoda* as comprising a single family with the characteristics of the order. For the sake of avoiding circumlocution it has been found desirable to use certain technical expressions. They are mainly those already used by Brooks, but it may be well at this point to indicate briefly their meanings. According to our present morphological ideas the thorax of the *Malacostraca* consists of eight somites, and those which are usually left uncovered by the carapace in the Squillidæ are therefore the fifth, sixth, seventh, and eighth, and sometimes the fourth is also exposed (fig. 13). In the posterior half of the carapace there is often an irregular transverse depression, known as the cervical suture, and there is always besides a pair of longitudinal sutures (pl. XXI). In the genus *Squilla* there are often five longitudinal carinæ upon the carapace—an unpaired median one, an intermediate pair, and a lateral pair. The lateral carinæ are often continued into the anterior lateral spines, while the intermediate ones usually extend as marginal carinæ around the edges of the posterior lateral lobes (pl. XXI). The eyes are often flattened and have the corneal portion divided into two lobes. In that case there are two principal axes—the peduncular axis (*ab*, fig. 14), running from the base of the peduncle to the line between the lobes, and the corneal axis (*cd*, fig. 14), coinciding with the greatest diameter of the corneal portion. The three distal segments of the great raptorial limb are known as the carpus, manus, and dactylus (*c*, *m*, and *d*, fig. 7). In the higher species of *Squilla* there are eight principal ridges or carinæ upon the abdominal somites described as submedian, intermediate, lateral, and marginal (fig. 9, *sc*, *ic*, *lc*, and *mc*). The seventh abdominal somite, or telson, usually has a dorsal median carina, that I shall speak of as the crest, and there is sometimes a ventral one that may be called the keel. The projecting points on the margin of the telson fall into two series. The larger ones are the marginal spines, of which there are usually six (figs. 9, 16, *sm*, *im*, and *l*), with sometimes indications of an additional pair (fig. 16, *al*); the smaller ones are the denticles, of which there are six sets (fig. 16, *sd*, *id*, and *ld*). The arrangement of the denticles for each species is often characteristic and may be expressed in a formula. The formula for *Squilla mantis* is 3–4, 4–8, 1; which means that in this

species one may expect to find on each side of the median line of the telson three or four submedian denticles, from four to eight intermediate ones, and one lateral one.

ANALYTICAL KEY TO THE GENERA OF SQUILLIDÆ.

I. Sixth abdominal somite more or less completely fused with the telson.
The dactylus of the raptorial limb dilated at the base and without lateral teeth. PROTOSQUILLA, Brooks.

II. Sixth abdominal somite separated from the telson by a flexible joint.

1. Dactylus of the raptorial limb dilated at the base, and the manus without pectinations.

a. Antennary scales and uropods not unusually small.

Hind body strongly convex; raptorial dactyli without lateral teeth. GONODACTYLUS, Latreille.

Hind body moderately convex; raptorial dactyli armed with lateral teeth.......................... ODONTODACTYLUS, new genus.

b. Antennary scales and uropods very small; hind body depressed; raptorial dactyli with lateral teeth.................. CORONIDA, Brooks.

2. The dactylus of the raptorial limb, as a rule, not dilated at the base (dilated in *Leptosquilla*) and the manus provided with minute pectinations on the inner margin.

a. Telson with 6 marginal spines and never more than 4 denticles between the submedian and intermediate spines.

Body compact and convex; dactylus of raptorial limb not dilated and with not more than 3 lateral teeth or unarmed. PSEUDOSQUILLA, Guérin.

Body loosely articulated and flattened; dactylus of raptorial limb not dilated and with at least 5 lateral teeth.. LYSIOSQUILLA, Dana.

b. Telson with 6 (rarely 8) marginal spines and, as a rule, with more than 4 intermediate denticles.

* Lateral margins of the first 5 abdominal somites expanded to equal three-fourths of the width of the median portion, measured between articulations.

Raptorial dactylus not dilated, with 10 to 11 teeth; abdomen, except the sixth somite, without submedian carinæ. PTERYGOSQUILLA, Hilgendorf.

** Lateral margins of the abdominal somites not greatly expanded, about one-fourth the width of the median portion.

Ophthalmic segment greatly elongated and prolonged beyond the rostrum for more than half its length; raptorial dactylus dilated at the base; abdomen, except sixth somite, without submedian carinæ; eyes cylindrical .... LEPTOSQUILLA, Miers.

Ophthalmic segment not greatly elongated; raptorial dactylus not dilated, or very slightly so.................. SQUILLA, Fabricius.

Genus GONODACTYLUS, Latreille.

Gonodactylus, LATREILLE, Encycl. Méth. Hist. Nat., X, p. 473, 1825; Cr. in Cuvier, Règne Anim., IV, p. 109, 1829.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 528, 1837.—DE HAAN, Siebold's Fauna Japonica, Crust., p. 220, 1849.—DANA, U. S. Expl. Exp., XIII, p. 615, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5) v, p. 115, 1880.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 55, 1886.

Diagnosis.—Stomatopoda having a movable joint between the sixth abdominal segment and the telson; the hind body convex; the dactylus of the raptorial claw enlarged at the base and with a sharp inner

edge that fits into a groove on the manus, and is without lateral teeth; and no pectinations upon the manus.

Remarks.—This genus, as it was defined by Miers (1880), included all those species in which the raptorial claw is without pectinations on the penultimate joint and has the dactylus dilated at the base. From this Brooks (1886) has separated two groups of species. One, the genus *Protosquilla*, includes forms having the dactylus unarmed and the telson fused with the sixth abdominal segment; the other, the genus *Coronida*, is composed of those species having the hind body depressed, the dactylus armed with spines on the inner edge, and possessing very small antennary scales and uropods. The forms that have remained up to this time in the genus *Gonodactylus* fall naturally into two groups, one clustered around the well-known *G. chiragra*, Latreille, and the other around *G. scyllarus*, Linnæus. These two groups are so distinct that I am convinced that they should be given the rank of distinct genera. The first group forms the genus *Gonodactylus* proper and corresponds exactly to Brooks's definition, while the other, for which I propose the name *Odontodactylus*, would be excluded by his definition, and will be described below.

ANALYTICAL KEY TO THE SPECIES OF GONODACTYLUS.

* Telson with 3 rounded longitudinal prominences on the dorsal side.

Whole dorsal surface of telson beset with fine prickles, only the submedian marginal spines well developed, the other 2 pairs obsolete; sixth abdominal somite with 6 smooth carinæ........................ SPINOSUS, Bigelow.

Like the above, but with only 4 distinct carinæ on the sixth abdominal somite, the whole dorsal surface of which is covered with prickles. SPINOSISSIMUS, Pfeffer.

Dorsal surface of telson without prickles; two pairs of marginal spines well developed, only the lateral pair obsolete.............. CHIRAGRA, Fabricius.

* * Telson with more than 3 narrow carinæ on the Dorsal side, and all 6 marginal spines developed.

The 5 narrow carinæ of the telson grouped together on a hemispherical prominence .... GLABROUS, Brooks.

Seven closely packed dorsal carinæ on the telson............. GRAPHURUS, Miers.

GONODACTYLUS SPINOSUS, Bigelow.

Gonodactylus spinosus, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 101, June, 1893.

Diagnosis.—A *Gonodactylus* having cylindrical eyes, a transverse rostrum, with a long median spine and subacute antero-lateral angles; a smooth carapace, nearly oblong, the posterior margin being straight, but the rounded antero-lateral lobes projecting forward; the hind body strongly convex; the lateral margins of the first exposed thoracic segment not produced, of the next three segments rounded; the first five abdominal segments smooth above and with lateral marginal carinæ, the sixth segment with six broad and smooth dorsal carinæ, each ending in a spine; three high, rounded, longitudinal dorsal prominences on

the telson, the whole dorsal surface beset with numerous minute prickles; two large submedian marginal spines, with minute movable tips, the intermediate and lateral spines being obsolete, and the basal prolongation of the uropod ending in two flattened curved spines, of which the outer is the longer.

General description.—Except for the telson, this species corresponds in structure almost exactly with the well-known *G. chiragra*, Latreille. The telson also resembles that of the last-named species, but it has striking and characteristic differences. The three central dorsal prominences are higher than in *G. chiragra*, broader and more closely pressed together. The vertical diameter of the telson exceeds half the horizontal diameter, which is not the case in the other species. The basal carinæ of the submedian and intermediate marginal spines are represented by broad, rounded, longitudinal prominences, separated from each other and from the central ones by narrow grooves. The lateral marginal pair of carinæ is inconspicuous. But what is most characteristic is that the whole dorsal surface of the telson, except the bottom of the grooves, is roughened by minute projecting spines. The telson appears at first sight to have but a single large pair of marginal spines. Closer examination, however, reveals two small teeth on each side that are evidently homologous to the intermediate and lateral spines of such a form as *G. graphurus*, for instance. The submedian spines have a large number of minute denticles on their inner margins.

The first antennæ are short, the second joint not extending beyond the eyes. The second antennæ are nearly as long as the first pair, but the antennary scale is small, not larger than half the short carapace. The basal prolongation of the uropod is broad and flat and the spines are curved inward. The outer one has no tooth on its inner margin. The distal segment of the exopodite is about half as long as the proximal one, which bears nine movable spines.

When I published my preliminary description of this species I had not seen Pfeffer's paper (1889) in which he describes a very similar species from Zanzibar, *G. spinosissimus.* It is possible that the two forms may prove finally to be merely varieties of a single species, but at present they appear to be distinct in spite of the fact that they disagree in very few particulars. The chief differences are in the fifth and sixth abdominal somites. In our specimens there is but a single pair of carinæ on the fifth somite, and the sixth bears six prominences with smooth and shining surfaces, the spaces between being somewhat pubescent. Each prominence or carina is tipped with a spine. The outer pair are the longer, the other four are of more nearly the same length, the intermediate pair being smaller and a trifle shorter than the submedian pair. The other form, on the contrary, has, according to Pfeffer, two pairs of carinæ on the fifth abdominal somite, and on the sixth there are four rounded knobs, the middle pair near one another and separated from the lateral by a deep furrow. The last-mentioned pair is also

separated by furrows from the lateral portions of the somite, which are hardly at all elevated. Both these lateral portions and the knobs are thickly beset with strong upright independent spinules. In the absence of any intermediate form, *G. spinosus* may be regarded as a distinct species.

Size.—Length of the body, 2 cm.

Locality.—Two female specimens, No. 4295, U.S.N.M., were collected by Col. N. Pike at Mauritius.

GONODACTYLUS CHIRAGRA (Fabricius).

Mantis marina barbadensis, PETIVER, Pterigraph, Americ, pl. XX, fig. 10.

Squilla chiragra, FABRICIUS, Ent. Syst., II, p. 513, 1793. Desmarest, Consid. Crust., p. 251, pl. XLIII, 1825.

Cancer (Mantis) chiragra, HERBST, Naturg. Krabben, II, p. 100, 1796.

Gonodactylus chiragra, LATREILLE, Encycl. Méth., X, p. 473, 1825.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 118, 1880.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 56.

Gonodactylus smithii, POCOCK, Ann. and Mag. Nat. Hist. (6), XII, 1893.

The collections of the U. S. Fish Commission and the National Museum contain a large number of specimens of this species from numerous localities among the Florida Keys, in the Gulf of California and the Abrolhos Islands. One specimen (No. 9493, U.S.N.M.) was collected by the *Albatross* at station 2323, off Havana, Cuba, at a depth of 163 fathoms, and I have added to the collection specimens taken in a foot or two of water on the sand flats in the Bimini Islands, Bahamas. They are common there, hiding among the algæ and under shells and stones. One specimen was found in a red sponge. When disturbed they move from one shelter to another with great rapidity. The coloring is distinctly protective, varying from a mottled green and white to a nearly pure green. I have also to record the occurrence of this species in burrows in the rock at Port Henderson, Jamaica.

In addition to these there is a single small specimen collected by W. L. Abbott in the Indian Ocean (No. 18457, U.S.N.M.) and a number of small specimens collected by Col. N. Pike at Mauritius (No. 2202, U. S. N. M.). These differ from the *G. chiragra* of our coast in that the carinæ of the sixth and terminal abdominal segments are narrow instead of being broadly rounded.

ODONTODACTYLUS, new genus.

Odontodactylus (subgenus), BIGELOW, Johns Hopkins Univ. Circ., 106, p. 100, June, 1893.

Gonodactylus (part), LATREILLE, Encycl. Méth. Hist. Nat., X, p. 473, 1825.—BERTHOLD, Abhandl. k. Gesellsch. Wiss. Göttingen, III, p. 30, 1847.—DE HAAN, Siebold's Fauna Japonica, Crust., p. 225, 1849.—WHITE, Proc. Zool. Soc., 1850. p. 96.—A. MILNE-EDWARDS, Nouv. Archiv. Mus. Hist. Nat., IV, p. 65 (footnote), 1868.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 115, 1880.—VON MARTENS, Sitz.-Ber. Gesel. Naturf., Berlin, 1881, p. 93.—POCOCK, Ann. and Mag. Nat. Hist. (6), XII, 1893.

Diagnosis.—Stomatopoda having a movable joint between the sixth abdominal somite and the telson; the hind body moderately convex;

the dactylus of the raptorial limb dilated at the base and provided with lateral teeth; the rostrum more or less triangular but not produced into a spine; the telson strongly resembling that of the genus *Pseudosquilla*, and as a rule with not more than two intermediate denticles.

Remarks.—This genus, which occupies an intermediate position between *Gonodactylus* and *Pseudosquilla*, was described by me in a preliminary paper (1893) as a subgenus of *Gonodactylus*, but it is sufficiently distinct to merit the rank assigned to it here.

ANALYTICAL KEY TO THE SPECIES OF ODONTODACTYLUS.*

*Dactylus of raptorial limb with 2 lateral teeth.

Rostrum transverse and subtriangular; median crest of telson elevated. SCYLLARUS, Linnæus.

Rostrum enlarged at the base and ending in a point; median crest of the telson lamellate, but much less elevated than in the next. BLEEKERII, A. Milne-Edwards.

Rostrum quadrilateral; median crest of the telson lamellate and with a vertical height nearly equal to its distance from the lateral margin. CULTRIFER, White.

Dactylus but little ventricose at the base; rostrum somewhat transverse, not acute; telson as broad as long dorsally, nearly smooth, with an acute crest ending in a spinule .... ELEGANS, Miers.

**Dactylus with more than 2 lateral teeth.

Dactylus with 3 teeth; rostrum pentagonal with a short median point. TRACHURUS, von Martens.

Dactylus with 3 teeth; rostrum ovately convex, its extremity bent downward; eyes very large and globular .... CARINIFER, Pocock.

Dactylus with 5 to 7 small serrations on its inner margin; rostrum sinuate at the sides, tip obtuse and strongly incurved .... JAPONICUS, Berthold.

Dactylus with 6 small lateral teeth; rostrum not sinuate but transverse and rounded in outline; eyes very large .... HAVANENSIS, Bigelow.

Dactylus with 9 teeth; rostrum with evenly convex anterior border and evenly rounded angles; eyes large .... HANSENII, Pocock.

Dactylus very little ventricose at base and with about 8 teeth on its inner margin; rostrum transverse .... BREVIROSTRIS, Miers.

ODONTODACTYLUS SCYLLARUS (Linnæus).

Squilla arenaria prona, SEBA, Thesaurus, III, p. 5, 1758.

Cancer scyllarus, LINNÆUS, Syst. Nat. (ed. XII), p. 1054, 1766.

Squilla scyllarus, FABRICIUS, Ent. Syst., II., p. 512, 1793. LAMARCK, Hist. Anim. sans Vert., V, 1818, p. 189.

Cancer (Mantis) scyllarus, HERBST, Nat. Krabben, etc., II, p. 99, 1796.

Gonodactylus scyllarus, LATREILLE, Encycl. Méth., X, p. 473, 1825. etc.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 115, 1880.

*All of the species in this key, except *havanensis*, have been described previously as species of *Gonodactylus*.

There is a female specimen in the National Museum, collected by A. B. Steinberger, at Samoa (No. 5147, U.S.N.M.).

Length of the body, 14 cm.

ODONTODACTYLUS HAVANENSIS, Bigelow.

Plate XX.

Gonodactylus havanensis, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 101, June, 1893.

Diagnosis.—An *Odontodactylus*, having large, subspherical eyes; large antennal scales; the dactylus of the raptorial claw strongly dilated at the base and provided with six small marginal teeth besides the terminal one; a transverse rostrum without angles; a nearly square carapace with rounded corners; three exposed thoracic segments with rounded margins; six spines on the sixth abdominal segment; a dorsal crest and four other carinæ on the telson, six marginal spines, the submedian pair with mobile tips, and numerous minute submedian denticles, two intermediate, and one lateral one on each side; rather large uropods with two simple basal spines, the outer one the longer.

General description.—A single specimen of this interesting species was found in a bottle with a young *G. chiragra* both having been collected by the *Albatross* in the Gulf of Mexico, off Havana. The body is short and broad, and is convex on the dorsal side (pl. XX). The sides of the carapace, thoracic segments, and abdomen form nearly a straight line. The width of the carapace at the anterior end equals one-fifth of the length of the body, while the width of the abdomen at the fifth segment equals about one-fourth of it. The rostrum is twice as broad as it is long and is evenly curved in front. The carapace is almost perfectly square. It is a little narrowed in front and the posterior and anterior margins are slightly incurved. Only three thoracic segments are exposed. These have rounded margins and like the carapace and the first five abdominal segments are devoid of carinæ. The third, fourth, and fifth abdominal segments have posterior lateral spines. The sixth segment has six carinæ ending in spines and two additional tubercles on each side, one between the submedian and intermediate carinæ and another between the intermediate and lateral ones. There are no spines at the articulations of the uropods (fig. 1). The telson has a narrow elevated dorsal median crest ending in a

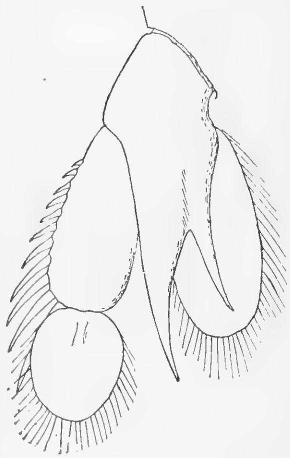


Fig. 1.

RIGHT UROPOD OF ODONTODACTYLUS HAVANENSIS.

Ventral side, five times natural size.

spine. The distance through the posterior part of the crest to the ventral surface of the telson is about equal to one-fourth of the width of the telson. The other four carinæ are less elevated. The marginal spines are prominent and the movable tips of the submedian pair are much longer than in *O. scyllarus*. The basal prolongation of the uropod (fig. 1) is continued into two simple spines of which the outer one is the longer but is not so long as the exopodite. The distal joint of the latter is about two-thirds as long (measured on the ventral side) as the proximal one, which bears eleven movable spines. The eyes are very large, but are subspherical and not at all triangular. The width of the cornea equals 0.09 of the length of the body. The first antennæ are short, the first three segments hardly extending beyond the eyes and almost equaling the flagella in length. The second antennæ reach almost as far forward as the first pair. The antennary scales are large, very nearly equaling the carapace in length and half as wide. The raptorial claw is rather small. When folded it only reaches backward to the cervical suture of the carapace, and the dactylus is only three-fourths as long as the manus. The latter is devoid of spines or pectinations of any kind, and is provided with a simple continuous groove for the reception of the dactylus when closed. The dactylus is strongly dilated at the base, and is provided with six very small and thin teeth on its inner edge. The appendages to the pleopod are linear. A remarkable peculiarity of the specimen before me is that while it is a male it is like a female in having no clasping organs on the exopodites of the first abdominal appendages, which are just like the succeeding ones (fig. 2).

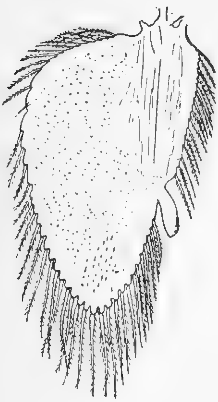


Fig. 2.

ENDOPODITE OF ODONTODACTYLUS HAVANENSIS.

Endopodite from first abdominal limb. Nine times natural size.

It is probable that this is a very young specimen, and some of its characters may be due to its youth, but a young *G. chiragra* of the same size possesses the clasping organs and exhibits all the adult features.

Color.—The alcoholic specimen has a dark spot on the carapace and black markings on the uropods.

Size.—Length of body, 2 cm.

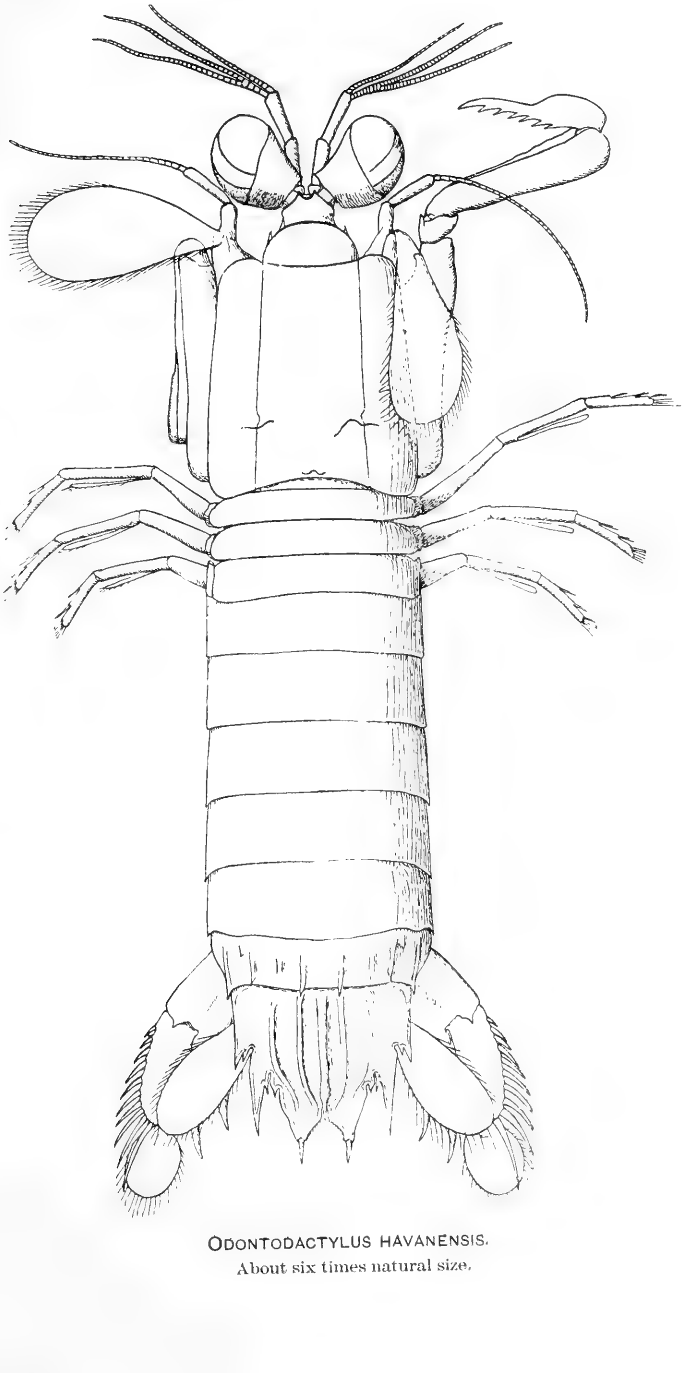
Locality.—The unique specimen was taken by the *Albatross* in 1885 at station 2323 at a depth of 163 fathoms off Havana, Cuba. (No. 17997, U.S.N.M.)

Genus PSEUDOSQUILLA (Guérin).

Squilles trapues, MILNE-EDWARDS, Hist. Nat. Cr. II, p. 525, 1837.

Squillæ (sect. iii) *parallelæ*, DE HAAN, Siebold's Fauna Japonica, Cr., p. 221, 1849.

Pseudosquilla, GUÉRIN (ined.), DANA, U. S. Expl. Exp., XIII, Cr., I, p. 615, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 108, 1880.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 53, 1886.



ODONTODACTYLUS HAVANENSIS.
About six times natural size.

Diagnosis.—Stomatopoda, with the sixth abdominal segment not fused with the telson; the hind body smooth, very convex, and narrow; the dactylus of the raptorial claw not dilated at the base and possessing not more than three lateral teeth, or in some cases none; the submedian spines of the telson long and having movable tips; not more than four intermediate denticles, usually one.

Remarks.—This genus is, as a whole, compact and well defined, but the three species that I have placed under B in the key are of doubtful affinities. *P. monodactyla*, Milne-Edwards, may prove to be an immature form; *P. stylifera*, Milne-Edwards, approaches *Gonodactylus* very closely; and *Gonodactylus ensiger*, Owen, seems to be closely related to the last.

ANALYTICAL KEY TO THE SPECIES OF PSEUDOSQUILLA.

A. *Pseudosquilla*, proper. Hind body narrow and thick; raptorial claw armed with a few marginal spines.
- *a.* Basal prolongation of the uropod ending in 2 spines; dactylus with 3 teeth.
  - * Telson with crest and 4 other carinæ.................? EMPUSA, De Haan.
  - * * Telson with a crest and 6 other carinæ.
    - Eyes small and cylindrical.................................CILIATA, Miers.
    - Eyes flattened, club-shaped, 2 eye-spots on carapace....ORNATA, Miers.
  - * * * Telson with crest and 8 other carinæ.
    - Eyes flattened, club-shaped; rostrum with small median spine. OCULATA, Brullé.
    - Eyes very large and triangular; rostrum without a spine. MEGALOPHTHALMA, Bigelow.
- *b.* Basal prolongation of the uropod ending in one long terminal spine having 2 other spines on its inner margin. Telson with crest and 10 other carinæ.
  - * Dactylus with 3 teeth.
    - Rostrum with a long median and 2 short lateral spines. LESSONII, Guérin.
    - Rostrum with prominent median spine but no lateral ones. CERISII, Roux.
  - * * Dactylus with 4 teeth; telson wider than long.......PILAENSIS, de Man.

B. *Doubtful position.* Dactylus with a single terminal spine.
- Telson smooth except for crest; many very minute submedian denticles; rostrum almost subtriangular, acute........MONODACTYLA, Milne-Edwards.
- Telson with crest and 2 other carinæ; rostrum longer than wide, narrowed at the end..............................STYLIFERA, Milne-Edwards.
  - Rostrum trispinose, median spine obsolete. (? GONODACTYLUS) ENSIGER, Owen.

PSEUDOSQUILLA CILIATA, Miers.

? Squilla ciliata, FABRICIUS, Ent. Syst., II, p. 512, 1793.

Squilla stylifera, LAMARCK, Hist. Anim. sans Vert., V, p. 189, 1818.—LATREILLE, Encycl. Méth., X, p. 472, 1825.

Pseudosquilla stylifera, DANA, U. S. Expl. Exp., XIII, Cr., I, p. 622, 1852.—? VON MARTENS, Archiv. f. Naturg., XXXVIII, p. 146, 1872.

Pseudosquilla ciliata, MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 108, 1880.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 53.

This species is represented in the National Museum by a large number of specimens from the Florida Keys; one from Bermuda (Dr. F. V. Hamlin) (No. 5136, U.S.N.M.), and another from Honolulu (?) (No. 6584, U.S.N.M.). I found it also in abundance at Bimini, in the Bahamas, associated with *Gonodactylus chiragra* and resembling that species very closely in habits and coloring.

PSEUDOSQUILLA ORNATA, Miers.

? *Pseudosquilla oculata*, HELLER, Reise der Novara, Crust., p. 124, 1865, not BRULLÉ.
Pseudosquilla ornata, MIERS, Ann. and Mag. Nat. Hist. (5), v, p. 111, 1880.

The National Museum contains one specimen of this species, purchased from H. A Ward (No. 15629, U.S.N.M.).

Locality.—Mauritius.

Length of body, 7.5 cm.

PSEUDOSQUILLA OCULATA (Brullé).

Squilla oculata, BRULLÉ, in WEBB and BARTHELOT, Iles Canaries, Zool. Crust., p. 18, 1836–'44.
Pseudosquilla oculata, MIERS, Ann. and Mag. Nat. Hist. (5), v, p. 110, 1880.

There is a small specimen in the National Museum that seems to belong to this species. It was collected by Col. N. Pike, U. S. Consul at Mauritius (No. 5137, U.S.N.M.).

The localities for this species given by Miers are the Canaries and Madeira.

PSEUDOSQUILLA MEGALOPHTHALMA, Bigelow.

Pseudosquilla megalophthalma, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 101, June, 1893.

Diagnosis.—A *Pseudosquilla* with very large triangular eyes, the corneal axis being transverse; a very long, slender dactylus on the raptorial claw, with three teeth; a nearly heart-shaped rostrum without spines; narrow, rounded lateral processes on the first exposed thoracic segment, the lateral margins of the next two segments truncated; posterior lateral spines on the abdominal segments from the second to the fifth, and the usual six spines on the sixth segment, with a smaller additional one on the inner side of each intermediate spine; a crest and eight other carinæ on the telson, six marginal spines, the submedian pair being the longest and mobile; two simple spines on the basal prolongation of the uropod, and ten movable spines on the exopodite.

General description.—In the collection of the U. S. National Museum we have three specimens of *Pseudosquilla* from Mauritius, representing as many species. One of these may be identified as *P. ornata*, Miers, another as *P. oculata*, Brullé, and the third (No. 18003, U.S.N.M.) is a new species related to the other two, perhaps more closely to *oculata* than to the other. It is easily distinguished from both by its large triangular eyes. The conical axis is at right angles to the peduncular

one, which is eight-elevenths as long as the former and equals six one-hundredths of the total length of the body. The carapace is twenty-two one-hundredths of the total length and about two-thirds as wide as it is long. The abdomen is a little wider and the telson a little narrower. Its width is about equal to its length, leaving out the mobile spines, and this is about fourteen one-hundredths of the total length.

The rostrum is of a broad heart shape, truncated at the base. It is therefore intermediate in shape between the rostrum of *P. ornata* and *P. oculata*. The length equals five-sevenths of the width. It covers the ophthalmic segment completely. The carapace is relatively longer than in *P. ornata*, and is perfectly smooth and without angles. The lateral margins of the exposed thoracic segments are rounded and without spines—of the first they are narrow and of the next two broad and truncated. There is a pair of slight projections on the ventral side of the first segment corresponding to the ventral spines in Squilla, and there is a similarly placed pair of larger somewhat conical projections on the next segment. The abdominal segments from the first to the fifth have each a stout spine pointing downward and backward on the ventral median line. All but the first of these segments have the posterior lateral angle produced into short spines. The sixth segment has six broad dorsal carinæ ending in stout spines, and there is a small additional spine on the inner side of each of the regular intermediate ones. There is no spine in front of the articulation of the uropod. The telson is most nearly like that of *P. oculata*. It has the same number of carinæ, eight besides the crest, and the basal carinæ of the submedian and intermediate spines, but while in *P. oculata* the carinæ of the pair next the lateral marginal pair are parallel to the axis of the body, and point toward the intermediate spines, in this species they are oblique and continue out to the tips of the lateral spines. The submedian carinæ are serrated. The ventral surface of the telson is perfectly smooth. There are no submedian denticles, two intermediate, and one lateral one. The outer one of the two spines of the basal prolongation of the uropod is the longest, and is very nearly as long as the exopodite, the distal segment of which is larger than in *P. ornata*. The antennæ are much longer than in the other two species. The first three segments of the first pair are three-fourths as long as the carapace, and the flagellæ are also of about this length. The antennary segment bears a truncated collar-like process on each side. The second antennæ are about three-fourths as long as the first.

The antennary scale is three-fifths as long as the carapace. The raptorial claws are very long and slender. When folded the limb reaches from the eyes to the most posterior part of the carapace. The pectinations are confined to the proximal half of the penultimate joint. The appendages to the walking legs are linear.

Size.—Length of the body, 6.8 cm.

Locality.—The single specimen, a male, was purchased from H. A. Ward, and it was collected at Mauritius.

PSEUDOSQUILLA LESSONII (Guérin).

Squilla cerisii, GUÉRIN, Voy. *Coquille*, Crust., p. 40, 1830 (*S. lessonii* on plate).
Squilla spinifrons, OWEN, Proc. Zool. Soc., p. 6, 1832.
Squilla lessonii,, MILNE-EDWARDS, Hist. Nat. Crust., II, p. 527.—WHITE, List Crust. Brit. Mus., p. 84, 1847.
Squilla monoceros, MILNE-EDWARDS, Hist. Nat. Crust, II, p. 526, 1837.—GAY, Hist. Chile Zool., III, Cr., p. 224, 1849.
Pseudosquilla lessonii, DANA, Crust. U.S. Expl. Exped., XIII, i, p. 622, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 113, 1880.
Pseudosquilla marmorata, LOCKINGTON, Proc. Cal. Acad. Sci., p. 33, 1877.

A female individual is in the National Museum, collected by D. S. Jordan at Wilmington, Cal. (No 3081, U.S.N.M.), and several smaller specimens were taken by the *Albatross* with the Tanner combination towing net at the surface at Surface station 29 in S. Lat. 00° 46′ 00″, and W. Long. 89° 42′ 00″ (No. 18481, U.S.N.M.).

Length of largest specimen, 13 cm.

PSEUDOSQUILLA STYLIFERA (Milne-Edwards).

Figure 3 (p. 505).

Gonodactylus styliferus, MILNE-EDWARDS, Hist. Nat. Crust., II, p. 530, 1837.—GAY, Hist. Chile, p. 225, 1849.
Pseudosquilla stylifera, MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 112, 1880.

A specimen undoubtedly belonging to this species is in the possession of the Johns Hopkins University, having been sent by F. W. Simonds. It was caught by a fisherman in a gill net off Dead Man's Island, San Pedro, Cal. This specimen corresponds exactly to Miers's description, except that the telson can hardly be said to have "8 large marginal teeth." It has the usual six marginal spines, the submedian pair having small movable tips, and a broad rounded denticle between the submedian and intermediate spine on each side. (See fig. 3, p. 505.) An additional minute movable spine should appear on the raptorial manus of this figure, and also a minute denticle on the outer edge of the basal prolongation of the uropod.

The color of the living animal, according to Mr. Simonds's memorandum, was violet.

The length of the body is 14.5 cm.

Genus LYSIOSQUILLA, Dana.

Coronis, LATREILLE, Encycl. Méth. Hist. Nat., X., p. 474, 1825; Crust. in Cuvier's Régne Anim., IV., p. 109, 1829.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 530, 1837.—GERSTAECKER, Arthropoda, in Bronn's Klass. und Ord. des Thierreichs, V, ii, p. 743, 1889.
Squilla (§), MILNE-EDWARDS, Hist. Nat. Crust., II, p. 518, 1837.
Squilla (sect. i, *Maculatæ*), DE HAAN, Fauna. Japon. Crust., p. 220, 1849.
Lysiosquilla, DANA, Crust. U. S. Expl. Exped., XIII, p. 615, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 5, 1881.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 44, 1886.

Diagnosis.—Stomatopoda having the sixth abdominal segments separated from the telson by a movable joint; the hind body depressed, loosely articulated, and wide; the dactylus of the raptorial claw without a basal enlargement, but with not less than five marginal teeth; no more than four denticles, and often only one, between the intermediate and submedian marginal spines of the telson, which is usually wider than long; and the outer spines of the basal prolongation of the uropod usually longer than the inner one.

Remarks.—Although the name *Coronis* antedates *Lysiosquilla*, the latter is the proper name for this genus, because the former was used first by Hübner in 1816 for a genus of *Lepidoptera*. The species of *Lysiosquilla* may be separated into two subgroups; one, corresponding to Latreille's genus *Coronis*, includes those in division A and B *a* of the following key. They all have small eyes and broad appendages to the walking legs. The three species in B *a*, however, have characters which place them in an intermediate position between A and B *b*, the latter division corresponding to Dana's genus *Lysiosquilla* proper, which is characterized by the possession of large triangular eyes and linear appendages to the walking legs. Brooks has pointed out the relationship between *Coronis* and the lower forms of *Squilla*.

ANALYTICAL KEY TO THE SPECIES OF LYSIOSQUILLA.

A. Telson with a transverse row of dorsal spines in addition to the marginal ones, eyes as a rule cylindrical.

a. Dactylus of the raptorial limb with 6 or 7 teeth.

* Five dorsal spines on the telson.

Telson with about 12 minute submedian denticles; rostrum quadrate with lateral angles right angles; dactylus with 6 teeth.
ACANTHOCARPUS (Gray) Miers.

The same, but dactylus with 7 teeth.
ACANTHOCARPUS var. SEPTEMSPINOSA, Miers.

Telson with 12 minute submedian denticles; lateral angles of rostrum rounded; dactylus with 6 teeth; transverse markings without eye-spots .... SARACINORUM, F. Müller.

Telson with 6 to 8 submedian denticles; not minute, transverse markings, with eye-spots on carapace and telson; dactylus with 6 teeth.
BIMINIENSIS, Bigelow.

* * Seven dorsal spines on the telson.

Dactylus with 6 teeth.................................. BRAZIERI, Miers.

Dactylus with 7 teeth .... LATIFRONS, de Haan.

b. Dactylus with 10 or 12 teeth.

Telson with 3 dorsal spines.......................... SPINOSA, Wood-Mason.

Telson with 8 scarcely discernible dorsal spines .... EUSEBIA, Risso.

[NOTE.—*Squilla indefensa*, Kirk (1879), and *Squilla tridentata*, Thomson (1882), are probably Lysiosquillae belonging in this section (Cf. Miers, 1880, p. 125), while *Squilla lævis*, Hutton (1879), appears to belong in this section or the next.]

B. Telson without dorsal spines.

a. Eyes small.

* Dactylus with 10 teeth. Eyes small, with cornea oblique and somewhat flattened; telson with 6 marginal spines, the submedian mobile, and on each side 7 to 9 minute submedian denticles, 4 intermediate and 1 lateral .... ARMATA, Smith.

* * Dactylus with 12 teeth. Eyes nearly globular; telson nearly square, without (?) teeth or spines .... SCOLOPENDRA, Latreille.

* * * Dactylus with 15 to 16 teeth. Eyes cylindrical; telson nearly square, with a pair of mobile submedian spines and 10 submedian denticles. EXCAVATRIX, Brooks.

b. Eyes large and subtriangular.

* Dactylus with 5 to 7 teeth. Telson smooth, with a slight median elevation and 6 marginal spines, only the lateral pair acute. GLABRIUSCULA (Lamarck) Meyers.

* * Dactylus with 9 to 10 strong teeth.

Hind body smooth and telson like the preceding. MACULATA Fabricius.

Hind body with longitudinal wrinkles; sixth abdominal somite grotesquely sculptured; telson smooth .... MIERSII, De Vis.

Telson roughened with fine granulations on each side of the flattened shield-like crest; 6 strong and acute marginal spines; submedian denticles fused .... SCABRICAUDA, Lamarck.

* * * Dactylus with 11 teeth. Telson like the preceding, but more spinous. DESAUSSUREI, Stimpson.

* * * * Dactylus with 20 teeth. Telson nearly as in *maculata*, eyes (?). POLYDACTYLA, von Martens.

LYSIOSQUILLA BIMINIENSIS, Bigelow.

Lysiosquilla biminiensis, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 102, 1893.

Diagnosis.—A *Lysiosquilla* having cylindrical eyes; 6 teeth on the dactylus of the raptorial claw, the terminal one the strongest; broadly ovate appendages on the first 2 pairs of pleopods and strap-shaped ones on the third pair; a nearly quadrate rostrum with a median spine; a smooth carapace without angles; the angles of the segments of the hind body rounded, except the posterior lateral angles of the sixth abdominal segment, which are produced into spines; a long spine curving backward on the anterior edge of the articulation of the uropod; a transverse row of 5 dorsal spines on the telson, and 6 marginal spines, the submedian pair being mobile; on each side 3 to 4 submedian denticles, not minute, 4 intermediate and 1 lateral one.

General description.—This species from the Bahamas may prove to be identical with the Australian *L. acanthocarpus*, but Miers does not mention the very striking coloring of our species, and the raptorial claw and the telson seem to differ.

The body (fig. 4) is rather flat, generally smooth, and somewhat loosely put together. The carapace and the exposed thoracic region each occupy a little less than one-fifth the total length of the body. The width of the carapace is about seventy-five-ninetieths of its length on the median line, while this is equaled by the greatest width of the abdomen. The length of the telson is three-sevenths its width and one-third the length of the carapace. The eyes are small and cylindrical and their bases are covered by the rostrum. The latter is nearly square and has a sharp median spine that reaches forward to the proximal edge of the corneal parts of the eyes. The carapace has

rounded anterior and posterior lateral lobes. The cervical suture is faintly marked on the outer side of each of the two longitudinal sutures.

The exposed thoracic and first five abdominal segments are devoid of carinæ or spines. The sixth abdominal has a short spine at each of its posterior lateral angles and a larger spine curved backward in front of the articulation of each uropod (fig. 5). The telson is perfectly smooth except for a transverse row of five spines on the dorsal side near the posterior margin (figs. 4 and 6). The mobile submedian

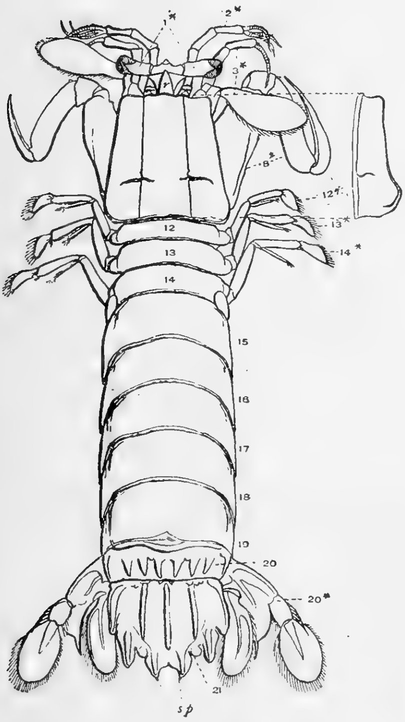


Fig. 3.

PSEUDOSQUILLA STYLIFERA.

Drawn by W. F. Simonds. About half natural size.

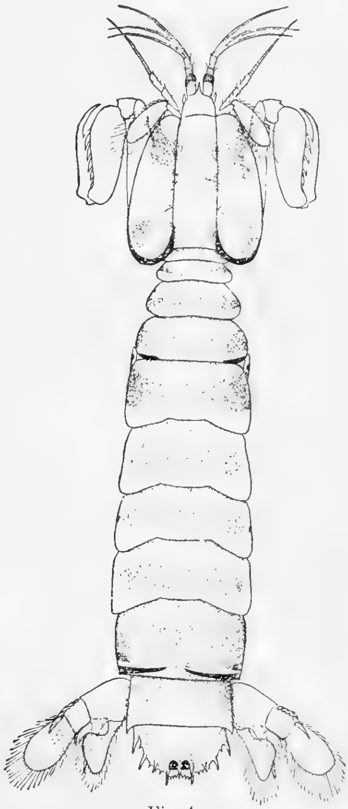


Fig. 4.

LYSIOSQUILLA BIMINIENSIS.

About twice natural size.

pair of marginal spines are placed a little toward the ventral side and are curved upward (figs. 5 and 6). They are not much longer than the adjoining denticles. Judging from Miers's figure, the marginal spines in our species as well as the submedian denticles are considerably larger than in *L. acanthocarpus*, and there appears to be no median sinus in the latter species, while there is a small one in the former. The basal segment of the uropod (fig. 5) bears two stout spines, of which the inner is much the longer. The endopodite is cleaver-shaped.

The distal segment of the exopodite exceeds in length the proximal segment, which bears six movable spines. The antennæ of the first pair are about equal to the carapace in length. The three basal segments do not reach much beyond the eyes. The antennary somite is armed with a pair of sharp lateral spines. The second antennæ are about as long as the first. The antennary scale is very small, about one-third as long as the carapace. The raptorial limbs are well developed, but are not very long (fig. 7). The carpus has a simple ridge on its anterior side ending distally in a spine. The manus is stout and bears four movable spines. The dactylus is slender and graceful. The terminal spine is much larger than the other five but the one next to it is not very small, as it is in *L. acanthocarpus*. The appendages to the first two pairs of walking legs are almost circular in outline, while they are strap-shaped on the next pair.

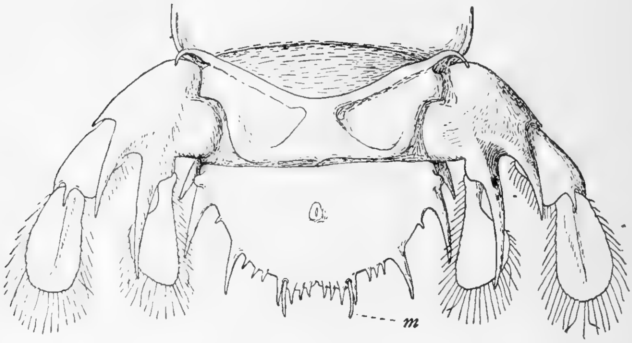


Fig. 5.

TELSON AND UROPODS OF LYSIOSQUILLA BIMINIENSIS.

Seen from below. Five times natural size. *m*.—Movable spine.

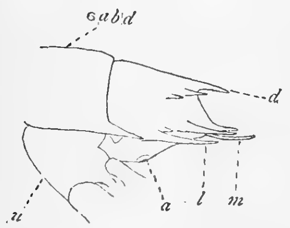


Fig. 6.

SIDE VIEW OF TELSON OF LYSIOSQUILLA BIMINIENSIS.

About 4½ times natural size.

d.—Dorsal median spine.
m.—Submedian mobile spine.
l.—Lateral spine.
6 *abd*.—Sixth abdominal somite.
a.—Anus.
u.—Uropod.

Color.—The coloration of this species is peculiar and characteristic. The ground color is an opaque white and this is marked by transverse bands, one on the rostrum, two or three on the carapace, and one on each of the segments posterior to it (fig. 4). On one of my two specimens, a male, these bands were fawn-colored, on the other one, a female, they were pink, and in addition to this fawn color or pink, as the case might be, the band was marked by a fine dark reddish brown stippling. In both specimens

the posterior lateral lobes of the carapace are bordered by a narrow band of deep black, separated from the rest of the carapace by a similar band of bright lemon yellow, forming conspicuous eye-spots. There are also two pairs of yellow and black stripes on the last thoracic and on the fifth abdominal segments bordering the posterior margin for some distance inward from the angle, and the telson has a pair of black eye-spots edged in front with yellow, one on each side of the median line, just in front of the dorsal spines. All except the black markings wash out in alcohol.

Size.—Length of body, 4.8 cm.

Locality.—Two specimens, a male and a female, were found by me in a burrow in the sand at Nixies' Harbor, Bimini Islands, Bahamas (No. 17999, U.S.N.M.).

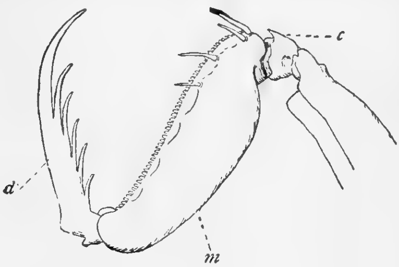


Fig. 7.

LEFT RAPTORIAL CLAW OF FEMALE LYSIOSQUILLA BIMINIENSIS.

About 4½ times natural size.

c. Carpus. m. Manus. d. Dactylus.

LYSIOSQUILLA ARMATA, Smith.

Lysiosquilla armata, Smith, Proc. U. S. Nat. Mus., III, 1881, p. 413.

The collection contains a female and a mutilated male from the stomach of a flounder. They were dredged by the U. S. Fish Commission steamer *Fish Hawk*, at stations 1247 and 1251, southwest of Gay Head, Martha's Vineyard, at a depth of 27 and 17 fathoms, bottom sand (No. 12787, U.S.N.M.). Although these specimens were identified by Prof. Smith himself, as shown by the label, they differ somewhat from his description. The eyes in both specimens are not large and are only a little more than half as broad as the rostrum. The posterior part of the body of the male is destroyed, but in the female the posterior margins of the fourth, fifth, and six abdominal segments and the lateral margins of the telson in front of the lateral spines are smooth, entirely devoid of the slender spines or spinules described by Smith. It may be that the possession of these spinules is a sexual character of the male. The telson of the female has six well-developed marginal spines, the submedian pair being very slender and mobile. There are seven to nine very small submedian denticles on each side, four intermediate ones, two of them being very large, flattened, and rounded in outline, and two others alternating with them, being very small and acute, and there is one small lateral denticle on each side. The rostrum is tipped with a small spine.

Size.—Length of body, 5.8 cm. Width of rostrum, 3 mm. Length of corneal axis of eye, 2 mm.; peduncular axis, 2.5 mm.

LYSIOSQUILLA GLABRIUSCULA, Miers.

? *Squilla glabriuscula*, LAMARCK, Hist. Anim. sans Vert., v., p. 188, 1818.—LATREILLE, Encycl. Méth. Hist. Nat., x, p. 470, 1825.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 519, 1837.

Squilla vittata, MILNE-EDWARDS, Hist. Nat. Crust., II, p. 519, 1837.—WHITE, List Crust. Brit. Mus., p. 83, 1847.—GIBBES, Proc. Amer. Assoc., p. 199, 1850.

Lysiosquilla glabriuscula, MIERS, Ann. and Mag. Nat. Hist. (5), v, p. 7, 1880.

There are two specimens of this species in the National Museum, collected by Dr. Whitehurst at Garden Key, Tortugas, Fla. (No. 2052, U. S.N.M.). They are a male and a female; the latter is the larger and is 21.3 cm. long. The dactyli of the raptorial claws of the male have six very long teeth. The female, on the contrary, has but three very short lateral teeth in addition to the long terminal one.

LYSIOSQUILLA MACULATA (Fabricius).

Squilla arenaria, RUMPH, Amboin. Rarit., p. 6, 1705.

Squilla maculata, FABRICIUS, Ent. Syst., II, p. 511, 1793.

Cancer (*Mantis*) *arenarius*, HERBST, Nat. Krabben u. Krebse, II, p. 96, 1796.

Lysiosquilla maculata, MIERS, Proc. Zool. Soc., p. 138, 1877; Ann. and Mag. Nat. Hist. (5), v, p. 5, 1880.—BROOKS, Voy. of the *Challenger*, XVI, ii, p. 45, 1886.

This species is represented by three specimens in the National Museum, a male collected by Dr. William H. Jones, U. S. Navy, of the U. S. S. *Wachusett*, at Tawhae, Marquesas, in 1884 (No. 6593, U.S.N.M.), and a female collected by A. B. Steinberger at Samoa (No. 5148, U.S.N. M.). The latter is 30 cm. in length and exhibits the same peculiarity of the raptorial claws that Miers describes. The dactylus has a stout terminal tooth and seven or eight very small lateral teeth. The third specimen (No. 3392, U.S.N.M.), also collected by Steinberger, is the raptorial claw of a male from Samoa and exhibits ten well-developed teeth (including the terminal one) on the dactylus. This is evidently a true case of sexual dimorphism.

LYSIOSQUILLA SCABRICAUDA (Lamarck).

Squilla scabricauda, LAMARCK, Hist. Anim. sans Vert., v, p. 188, 1818.—LATREILLE, Encycl. Méth. Hist. Nat., x, p. 470, 1825.

Squilla hoeveni, HERKLOTS, Addit. Faun. carcin. Afric. occident., p. 17, 1851.

Lysiosquilla inornata, DANA, U. S. Expl. Exped., XIII, Crust., I, p. 616, 1852.

Lysiosquilla scabricauda, MIERS, Ann. and Mag. Nat. Hist. (5), v, p. 7, 1880.

There are two specimens, a female and a young male, in the Museum, collected by Henry Hemphill at Johns Pass, Fla. (No. 6471, U.S.N. M.), one male specimen collected by D. S. Jordan at Key West, Fla. (No. 14112, U.S.N.M.), a female from Galveston, Tex. (M. Wallace, No. 2268, U.S.N.M.), and another from Pensacola, Fla. (Silas Stearns, No. 5150, U.S.N.M.), and a male collected by James D. Dana at Rio de Janeiro (No. 2115, U.S.N.M.). The dactyli of the raptorial claws seem to be a little smaller in the females than in the males, but there is nothing like the difference seen in *L. glabriuscula* and *L. maculata*.

Genus SQUILLA, Fabricius.

Squilla, FABRICIUS (part), Ent. Syst., II, p. 511, 1798.—LATREILLE (part), Hist. Nat. Crust., VI, p. 271, 1803; Encycl. Méth. Hist. Nat., X, p. 467, 1825.—LAMARCK (part), Hist. Anim. sans Vert., V, p. 186, 1818.—MILNE-EDWARDS (part), Hist. Nat. Crust., II, p. 517, 1837.—DE HAAN (part), Fauna Japon. Crust., p. 220, 1849.—DANA, Crust., U. S. Expl. Exped., XIII, i, p.615, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 16, 1880.—BROOKS, Voyage of the *Challenger*, XVI, ii, p. 23, 1886.—GERSTAECKER, Bronn's Klass. u. Ord. des Thier., V, ii, p. 742, 1889.

Chlorida, EYDOUX and SOULEYET, Voy. de la *Bonite*, Zool., I, Crust., p. 264, 1841.

Chloridella, MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 13, 1880.—GERSTAECKER, Bronn's Klass. und Ord. des Thier., V, ii, p. 743, 1889.

Diagnosis.—Stomatopoda having the telson attached to the sixth abdominal segment by a movable joint; the hind body depressed and wide; the dactylus of the raptorial claw with usually not more than six teeth; as a rule, more than four intermediate denticles on the telson, which is usually longer than wide; and the inner basal spine of the uropod the longer of the two.

Remarks.—This is by far the largest and most diversified of the genera of Stomatopoda. I have followed Brooks in including within it the old genus *Chloridella* (Eydoux and Souleyet) Miers, the chief characteristic of which is the shape of the eyes. The species that Miers referred to are contained in division B *a* of the following key, but no sharp line can be drawn between these and those species having the small eyes (e. g., *S. dubia*), which have been placed in different divisions of the genus, where many other characters indicate that they belong.

ANALYTICAL KEY TO THE SPECIES OF SQUILLA.

A. Submedian spines of the telson with movable tips.
- *a*. Submedian carinæ absent or obsolete on the first five somites of the abdomen.
  - *Dactylus of the raptorial limb with 4 teeth, including the terminal one.
    - Lateral process of the fifth thoracic somite very short and acute; no keel on the telson........................QUADRIDENS, Bigelow.
    - Lateral process of the fifth thoracic somite broad, curved slightly forward, and blunt; telson with a keel......POLITA, Bigelow.
  - **Dactylus with 5 teeth. Lateral process of the fifth thoracic somite flattened antero-posteriorly, short, straight, and blunt. DESMARESTII, Risso.
  - ***Dactylus with 10 teeth. Telson nearly smooth, with denticles 13, 18, 1. GRACILIPES, Miers.
- *b*. Submedian carinæ present on all abdominal somites, except the telson.
  - Dactylus with 4 teeth; 5 longitudinal crests on the telson.....MILES, Hess.
  - Dactylus with 7 to 9 teeth; telson with crest and keel, and curved lines of pits; denticles 0, 10–11, 1.......ARMATA, Milne-Edwards.

B. Submedian spines of the telson with immovable tips.
- *a*. Hind body without submedian carinæ except the sixth abdominal somite; eyes small.
  - *a*[1]. Raptorial dactylus with 4 teeth.
    - *Anterior lateral angles of the carapace rounded. ROTUNDICAUDA, Miers.
    - **Anterior lateral angles of the carapace produced into spines.
      - Rostrum semioval ................MICROPHTHALMA, Milne-Edwards.
      - Rostrum emarginate ....LATREILLEI, Eydoux and Souleyet.

a^{ii}. Dactylus with 5 teeth.

Rostrum wider than long.

CHLORIDA, Brooks. [=? DECORATA, Wood-Mason.]

a^{iii}. Dactylus with 6 teeth, eyes nearly cylindrical.

Telson with crest and obsolete curved lines of pits; denticles 0, 6–7, 1.

LATA, Brooks.

Telson with 4 or 5 carinæ on each side of the crest; denticles 4, 8, 1.

FASCIATA, de Haan.

b. 8 distinct carinæ on the first 5 abdominal somites, the dorsal surface of the telson on each side of the crest either smooth or marked by symmetrically curved lines of pits.

b'. Lateral process of the fifth thoracic somite on each side a single spine, a pair of ventral spines also present.

1. Eyes small.

Eye stalk dilated; lateral spine of the fifth thoracic somite prominent, flattened dorso-ventrally, and acute; denticles on telson 1–3, 3–4, 1 ....DUBIA, Milne-Edwards.

Eyes triangular, stalk not dilated; lateral spine of the fifth thoracic somite short, flattened antero-posteriorly, and blunt; denticles on the telson 3–4, 8, 1 ....PARVA, Bigelow.

2. Eyes large and triangular.

* Dactylus with 4 teeth. Denticles on the telson 12, 12, 1.

LEPTOSQUILLA, Brooks.

* * Dactylus with 5 teeth.

Lateral spine of the fifth thoracic somite straight and acute.

DUFRESNII (Leach), Miers=PRASINOLINEATA (Dana), Ives.

Lateral spine of the fifth thoracic somite longer and slightly curved..................PRASINOLINEATA (Dana ?), Miers.

Lateral spine of the fifth thoracic somite strongly falcate and acute .... SCORPIO, Latreille.

* * * Dactylus with 6 teeth.

Corneal and peduncular axes of the eye at right angles; lateral spine of the fifth thoracic somite short, straight, and acute; denticles on the telson 5–6, 11–12, 1....MANTOIDEA, Bigelow.

Corneal and peduncular axes of the eye nearly at right angles; lateral spine of the fifth thoracic somite curved forward and acute; marginal spines of the telson enormously developed in the males; denticles 3–4, 5–7, 1.......ACULEATA, Bigelow.

Corneal and peduncular axes of the eye distinctly oblique to one another; lateral spine of the fifth thoracic somite curved forward and acute; no thickening of the telson in males; denticles 4, 6–8, 1..........................EMPUSA, Say.

Lateral spine of the fifth thoracic somite straight and acute, margin of telson slightly thickened in males; denticles 3 or 4, 8–11, 1 ....MANTIS, Latreille.

Lateral spine of the fifth thoracic somite spatuliform, otherwise like *S. mantis* ....NEGLECTA, Gibbes.

Lateral spine of the fifth thoracic somite curved forward and acute; margin of the telson much thickened in males, the thickening being interrupted on the outer side of each of the 6 marginal spines; denticles 5, 10–11, 1–2.

PANAMENSIS, Bigelow.

Lateral spine of the fifth thoracic somite very strongly curved forward; marginal thickening on the telson of the males continuous between the intermediate spines; denticles 4–6, 10–13, 1.............................. INTERMEDIA, Bigelow.

Males with a continuous thickening all around the outer margin of the telson; keel produced into a sharp spine; denticles 5 to 7, 15–19, 1 .... BIFORMIS, Bigelow.

* * * * Dactylus with 8 teeth. Manus of raptorial limb with numerous immobile marginal spines ....RAPHIDEA, Fabricius.

b''. Lateral processes of the fifth thoracic somite bilobed; no ventral spines on this somite.

1. Eyes small. Median carina of the carapace deeply bifurcated. NEPA, Latreille.

2. Eyes large.

* Dactylus with 5 teeth. Lateral processes of the sixth and seventh thoracic somites bilobed.........QUINQUEDENTATA, Brooks.

* * Dactylus with 6 teeth.

Lateral processes of the sixth and seventh thoracic somites bilobed.......... AFFINIS, Berthold.

Lateral processes of the sixth and seventh thoracic somites not bilobed, posterior lateral angles of the carapace simply rounded.......... ALBA, Bigelow.

Lateral processes of the sixth and seventh thoracic somites not bilobate, posterior lateral angles of the carapace project as rather prominent lobes ....LÆVIS (Hess) de Man.

c. Eight or more carinæ on the first 5 abdominal somites, the dorsal surface of the telson marked by carinæ in addition to the median crest and the carinæ at the bases of the marginal spines and denticles.

c'. Eight abdominal carinæ.

* Dactylus with 3 teeth. Telson with 1 carina on each side of the crest.......... FERUSSACII, Roux.

* * Dactylus with 6 teeth. Telson with 10 carinæ on each side of the crest .... RUGOSA, Bigelow.

c''. More than 8 abdominal carinæ.

* Dactylus with 5 teeth.

Nine carinæ on the hind body ....SUPPLEX, Wood-Mason.

Very many carinæ on the hind body; lateral processes of the exposed thoracic somites bilobate..........MULTICARINATA, White.

* * Dactylus with 6 teeth. Hind body with 5 median and 6 lateral carinæ; lateral processes of the exposed thoracic somites bilobed .... COSTATA, de Haan.

SQUILLA QUADRIDENS, Bigelow.

Squilla quadridens, BIGELOW, Johns Hopkins Univ. Circ. 106, p. 100, 1893.

Diagnosis.—A *Squilla* with small triangular eyes having the corneal axis slightly shorter than the peduncular and somewhat oblique; dactylus of raptorial claw short, with four teeth; rostrum nearly flat and ovate; carapace without carinæ except at the posterior lateral angles, which are rounded, anterior lateral angles nearly right angles and subacute; exposed thoracic segments without sudmedian carinæ, lateral process of the first very short and acute, of the second and of the third broadly rounded; without submedian carinæ on abdominal somites except the sixth; telson having a low crest ending in a spine and shallow symmetrically curved furrows on each side, no ventral keel, six marginal spines, the submedian with mobile tips, and between them on each side four to five submedian teeth, six to eight intermediate, and

one lateral; uropod having four to five movable spines on its outer edge; its basal prolongation with six long teeth on its inner edge and a large rounded lobe on the outer edge of the inner spine.

General description.—Unfortunately this species has to be described from a single small specimen. The general form of the body is flattened and rather compact. The greatest width of the abdomen equals the length of the carapace and one-fourth of the total length of the animal, measured from the anterior extremity of the ophthalmic segment to the base of the median marginal sinus of the telson. The greatest width of the carapace equals nine-elevenths of itsl ength. The antero-lateral angles of the carapace are slightly less than right angles and are without spines, while the posterior corners form rather prominent rounded lobes. The only carinæ on the carapace are an incompletely circular marginal carina at each posterior lateral lobe and within this a short longitudinal carina representing the posterior portion of the lateral carina of some of the other Squillæ. The exposed thoracic segments have well-marked intermediate carinæ. The lateral spines on the first segment are compressed antero-posteriorly and are distinct from the ventral ones, which are acuminate and bent slightly forward.

The sixth abdominal segment is the only one that bears a pair of submedian carinæ; all the others have well-marked intermediate, lateral, and marginal carinæ. All six carinæ of the fifth and sixth segments end in spines. There are no spines on the sixth segment in front of the articulations of the uropod.

The width of the telson at its base nearly equals the length of the sixth abdominal segment and the telson taken together. The telson has six prominent marginal spines without a trace of an additional anterior lateral pair. The submedian spines in this specimen do not have movable tips, but microscopical examination shows articulations which indicate that they did possess movable tips, which have been broken off. The marginal teeth are long and sharp. The upper surface of the telson is ornamented by a longitudinal crest ending posteriorly in a spine and about five shallow furrows running from the crest outward and backward to the posterior margin. There are also some irregular furrowings near the lateral margin. There are faintly marked carinæ at the bases of the marginal spines, the lateral pair being continued forward along the margin to the base of the telson. The ventral surface is very faintly marked by furrows corresponding to the dorsal ones. The uropod has the two joints of the exopodite of equal length; on the external edge of the first joint there are five movable spines. The remarkable teeth on the inner edge of the prolongation of the basal joint are long and slender.

The eyes of this animal are rather small. The corneal region is elongated and slightly bilobed. The corneal axis nearly equals fourteen fifteenths the peduncular one, and is set somewhat obliquely to it. The peduncle is not dilated and is much narrower at its base than the

corneal region, so that the eye as a whole has a triangular outline. The ophthalmic segment bears a truncated process at the base of each eye.

The antennæ of the first pair are long, equaling about half the length of the body. The marginal spines of the first body segment are acuminate. The second antennæ are about two-fifths as long as the first. The antennary scales of this specimen have been lost. The raptorial claw when folded does not reach to the posterior margin of the carapace. The carpus has no spines. The dactylus is short and its outer margin has a simple curve broken only near the articulation by a small tubercle. It bears four slender teeth, of which the proximal one is much smaller than the others. The appendages of the walking legs are linear.

Color.—The alcoholic specimen is marked by a few dark pigment cells arranged symmetrically on the carapace and hind body.

Size.—Total length, 22 mm.

Locality.—The type specimen was taken by the *Albatross* in 1886, with a trawl at a depth of 26 fathoms, in N. Lat. 26° 5′ 0″ and W. Long. 80° 15′ 0″, off Key Largo, Fla.; bottom, coral sand. (No. 11547, U.S.N.M.)

Remarks.—It is with considerable hesitation that I found a new species upon this single specimen, which very closely resembles the next species, *S. polita.* I should have placed it in that species if I had not been able to compare it directly with a specimen of the same size. Such a comparison showed that in this species the eyes are smaller and the thoracic segments much wider, and there is an entire absence of the keel on the telson which the other possesses.

SQUILLA POLITA, Bigelow.

Squilla polita, BIGELOW, Johns Hopkins Univ. Circ., 88, 1891.

Diagnosis.—Eyes of medium size, triangular; dactylus of raptorial claw with four teeth; rostrum ovate without carinæ; carapace without carinæ, except on posterior lateral lobes, which are rounded, cervical suture obsolete on the median line, anterior lateral angles acute; lateral spine of the fifth thoracic segment broad, blunt, and curved forward, lateral margins of the next two segments rounded; hind body without submedian carinæ except the sixth abdominal segment; telson with a dorsal crest and ventral keel and a few curved lines of pits on each side; six large marginal spines, the submedian pair having movable tips, and on each side of the median sinus two to three submedian denticles, nine to twelve intermediate, and one lateral one.

General description.—This species is closely related to *Squilla desmarestii,* Risso, and has many points of resemblance to *S. armata.* The body is well arched, but somewhat less compact. The carapace is longer than the exposed thoracic segments, and a little less than half as long as the first six abdominal segments and about twice as long as

the telson. The whole dorsal surface of the animal has a highly polished appearance that suggested the name which I have given to the species. The rostrum is ovate, without carinæ, and it covers the first antennary segment. The carapace has a polished surface and is devoid of carinæ, except on the posterior lateral lobes, where the intermediate and lateral carinæ are present. The posterior median tubercle is obsolete. The cervical suture is obliterated for some distance on each side of the median line. The anterior lateral angles are short, acute spines. The posterior lateral lobes are evenly rounded. The distance between the anterior lateral angles equals twice the length and exceeds half the posterior width. The carapace differs from that of *S. armata* chiefly in the disappearance of the cervical suture on the median line and in the small depressed anterior lateral spines.

The exposed thoracic segments have no submedian carinæ, but the intermediate carinæ are prominent. The ventral spine of the fifth segment is elongated, curved forward, and acute. The lateral process is broadly flattened dorso-ventrally, slightly curved forward, and blunt. The margins of the next two segments are broadly rounded and without spines. Submedian carinæ are entirely absent in the abdomen, except on the sixth somite. Intermediate lateral and marginal carinæ are well marked and end in spines, except in the first two abdominal somites, where there are no spines.

The telson (fig. 8) is relatively smaller than in *S. desmarestii*, and is much wider than long. There are 6 long and sharp marginal spines, each having at the base a slightly raised carina; the spines of two outer pairs curve somewhat toward the median line. The submedian spines are jointed, and the movable distal part is longer than in *S. desmarestii*. The denticles are long and acute and extend along the outer edge of each submedian spine nearly to the joint. There are no anterior lateral carinæ.

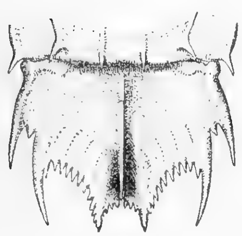


Fig. 8.

TELSON OF SQUILLA POLITA.

Three times natural size.

The crest has a sharp edge and rises rather abruptly from the general surface. It is interrupted by a depression near its anterior end, and its posterior end is extended into a long acute spine. The dorsal surface of the telson is polished, as in *S. desmarestii*, but in this species there are distinct symmetrically curved depressed lines and some shallow circular pits, showing in a rudimentary condition the same sculpturing found in *S. mantis* and its allies. The ventral surface is smooth except for obsolete curved depressed lines and a long prominent keel.

The eyes are of moderate size. The corneal portion, which is slightly constricted in the middle, is about equal, not longer, than the interior margin of the eye, and its long axis is at an angle of about 45° to the

long axis of the eye stalk. The anterior process of the segment is acute. The lateral processes are broad, flat, and truncated.

The first antennæ equal in length the distance from the end of the rostrum to the posterior end of the thorax.

The second antennæ reach to about the base of the flagella of the first pair. The exopodite is small.

The distal joints of the raptorial limb are short. The dactylus has four curved teeth and has a well-marked tubercle on the outer edge close to the articulation. The manus bears three movable spines, the middle one being much the smallest. The carpus has one blunt spine on the anterior side.

The prolongation of the basal joint of the uropod is not deeply serrated on the inner edge, but simply undulating. The inner process of the prolongation is not twice as long as the outer one and bears on its outer side at about the middle of its length a very conspicuous rounded tooth. There are five movable spines on the exopodite.

No secondary sexual differences appear.

Color.—An alcoholic specimen is marked in a way very similar to *S. mantis* except on the telson. There is a dark V-shaped spot at the end of the crest of the telson, and lines of pigment cells follow the line of pits.

Size.—The largest specimen is 6.3 cm. in length and the smallest 2.2 cm.

Locality.—All the specimens in the collection were taken by the *Albatross;* two males and one female from Santa Rosa Island, California (No. 18494, U.S.N.M.), one small male from off Abreojos Point, Lower Cailfornia (No. 18475, U.S.N.M.).

SQUILLA DESMARESTII, Risso.

Squilla desmarestii, RISSO, Crust. de Nice, p. 114, 1816.—MIERS, Ann. and Mag. Nat. Hist. (5) V, p. 28, 1880.

There are two males in the collection from the Channel Islands contributed by Edward Lovett, Esq., of London, England (No. 6542, U.S. N.M.). Miers fails to mention the eyes in his description. They are triangular, but small as compared with a specimen of *S. panamensis*, for example, of the same size.

SQUILLA ARMATA, Milne-Edwards.

Squilla armata, ?MILNE-EDWARDS, Hist. Nat. Crust., II, p. 521, 1837.—? GAY, Hist. de Chile, Zool. III, Crust., p. 223, 1849.—MIERS, Ann. and Mag. Nat. Hist. (5) V, p. 26, 1880.—BIGELOW, Johns Hopkins Univ. Circ., 88, 1891.

Diagnosis.—Eyes large, triangular; dactylus of the raptorial limb with seven to nine teeth; rostrum narrowed in front with a slight median elevation; carapace with median carina obsolete or entirely absent, intermediate and lateral carinæ present only on the posterior lateral lobes, anterior lateral angles produced into acute spines; lateral

spines of the fifth thoracic segment narrow, straight, and acute, the lateral processes of the next two segments broadly rounded and produced into spines that point backward; eight carinæ on the abdominal segments; telson with a crest and a keel and a series of curved lines of pits on each side, six marginal spines, the submedian pair with movable tips, no submedian denticles, ten to eleven small intermediate ones, and one lateral one.

General description.—The carapace is twice as wide behind as it is in front. The exposed part of thorax is as long as the carapace; and the abdomen, leaving out the telson, is twice as long. The abdomen is about the same width for its whole length. The telson is about as long as wide.

The rostrum is triangular, a little wider than long. The apex is blunt and rounded. In one specimen the apical margin is indented so

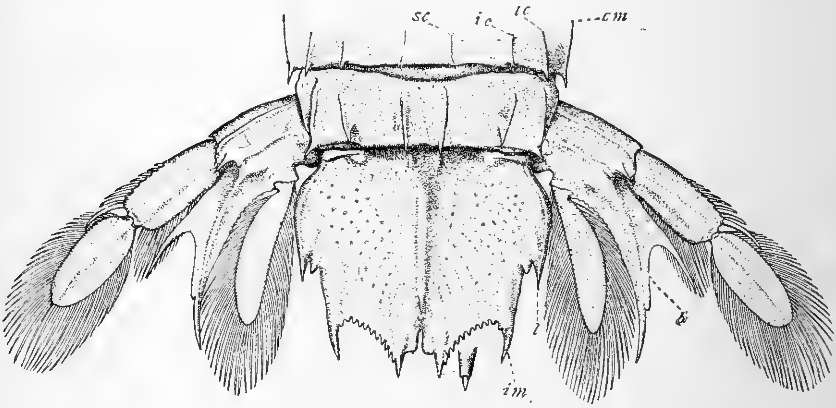


Fig. 9.

TELSON AND UROPODS OF SQUILLA ARMATA.

Twice natural size.

b.—Basal prolongation of uropod.
im., *l.*—Intermediate and lateral marginal spines.
sc., *ic.*, *lc.*, *cm.*—Submedian, intermediate, lateral, and marginal carinæ.

as to have four short teeth. The median and marginal carinæ are obsolete or entirely absent, and the dorsal surface is smooth except for a slight roughness in old specimens.

The carapace has generally a smooth, polished appearance. There is a well-marked transverse suture, but it makes only a slight depression across the median line. The posterior lateral lobes are evenly rounded, not angled.

The exposed thoracic segments possess submedian and intermediate carinæ. The fifth segment has a pair of short and acute ventral spines and a pair of much longer lateral processes that are straight, evenly tapering, and sharply acute.

On the lateral margins of the next two segments there is no trace of an anterior lobe. The marginal process is evenly rounded to the

posterior lateral edge where it is suddenly produced into a sharp spine directed backward and outward.

The segments of the abdomen, except the sixth, and the telson are all provided with submedian, intermediate, lateral, and marginal carinæ; the latter are absent in the sixth segment. All the carinæ end posteriorly in sharp spines except the submedian ones in the first five segments. In the posterior margin of the fifth segment on each side, half way between the submedian and intermediate carinæ, there are from one to four spines grouped together.

The telson (fig. 9) has little or no indication of an anterior lateral carina or spine. The submedian spines are jointed so that they have each a short and acute movable tip. The ventral surface has a keel which is deepest just posterior to the anus. The rest of the surface is smooth except for an obsolete series of curved lines corresponding with those of the dorsal surface. Between the submedian spines the margin is divided by a deep median sinus into two rounded lobes very much as in *S. lata*, and there are no teeth present except sometimes very minute dentations on the posterior edge. Between a submedian and intermediate spine there are ten or eleven conical teeth and between each intermediate and lateral spine there is one. These are very small elevations at the base of each tooth and spine.

The eyes are triangular, the corneal portion equals in length the distance along the inner edge of the eye from the anterior end of the corneal part to the anterior edge of the hard part of the stalk. The median process of the ocular segment is subacute. The lateral processes are rounded laterally, but the anterior margin of each gives rise to a stout, straight, rounded spine which points forward and slightly outward opposite the inner edge of the eye. The first antennæ are nearly as long as the carapace and exposed thoracic segments taken together. The antennary segment bears a pair of stout lateral processes curved forward and sharply acute.

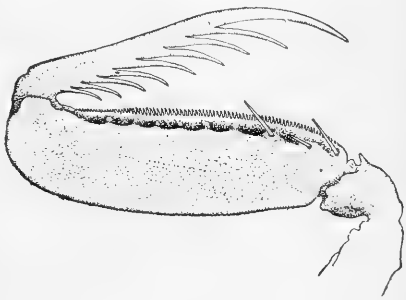


Fig. 10.

RAPTORIAL CLAW OF SQUILLA ARMATA.

Nearly three times natural size.

The flagellum of the second antenna does not reach quite to the base of the flagellum of the first antenna.

The raptorial claw (fig. 10) is stout. The dactylus is armed with seven to nine teeth, rarely six. There are three movable spines and a row of pectinations on the manus as usual. The anterior edge of the carpus has one tooth-like projection.

The uropods (fig. 9) are very much as in *S. panamensis*. In general the spines are more conspicuous, except the outer one of the prolongation of the basal joint, which is not half so long as the inner one. The small tooth (large in small specimens) is beyond the middle of the spine. The two joints of the exopodite are equal in length and the first one bears on its outer edge seven movable spines. The endopodite is narrowly spatulate, relatively a little broader than in *S. panamensis*.

There are no secondary sexual differences and no peculiarities of coloring in my specimens.

This species conforms to Miers's description of *S. armata* in every essential point that he covers.

Size.—The largest specimen in the collection is 12.2 cm. in length. Most of the specimens, however, are smaller, about 6 cm long.

Locality.—This collection of specimens consists of a good number of both sexes from four stations off the coast of Patagonia, viz., station 2769, off the Gulf of St. George (No. 18470, U.S.N.M.); station 2787, off Port Otway (No. 18472, U.S.N.M.); station 2783, off the west coast of Patagonia (No. 18505, U.S.N.M.); and Island Harbor (No. 18471, U.S.N.M.), the depth being from 51 to 122 fathoms.

SQUILLA DUBIA (Milne-Edwards?) Miers.

Squilla mantis, DESMAREST, Consid. Crust., p. 250, 1825.

Squilla dubia, ? MILNE-EDWARDS, Hist. Nat. Crust. II, p. 522, 1837.—? GIBBES, Proc. Amer. Assoc., VI, p. 200, 1850.—MIERS, Ann. and Mag. Nat. Hist., (5) V, p. 24, 1880.

? *Squilla rubrolineata*, DANA, Crust., U. S. Expl. Exped., XIII, i, p. 618, 1852.—VON MARTENS, Arch. f. Naturgesch., 37, p. 144, 1872.

The National Museum possesses three specimens of this species, a male collected by Dr. G. H. Macon, at Savannah, Ga. (No. 2524, U.S.N.M.), a young male collected by C. C. Leslie, Charleston, S. C. (No. 3139, U.S.N.M.), and a female found by Dr. W. H. Jones, U. S. Navy, in a salt lake near Guayaquil, Ecuador (No. 14113, U.S.N.M.).

The specimen from Savannah corresponds exactly to Miers's description. The lateral spine of the first exposed thoracic segment is straight in front but rounded behind. In the Charleston specimen it is curved forward a little as in *S. empusa*.

The specimen from Guayaquil is practically identical in form with the one from Savannah, except that there are one or two more denticles on each side of the telson. A character common to these specimens, and not mentioned by Miers, is the shape of the eyes. They are very small. The eye stalk is dilated in the middle and the corneal axis of the eye, while oblique, is shorter than the peduncular one.

SQUILLA PARVA, Bigelow.

Squilla parva, BIGELOW, Johns Hopkins Univ. Circ., 88, 1891.

Diagnosis.—Squillae with narrowly triangular eyes, the corneal part being shorter than the total length; dactylus of the raptorial claw having six teeth; triangular rostrum rounded anteriorly and provided

with median and marginal carinæ; five carinæ on the carapace, its anterior lateral angles produced into spines and posterior corners evenly rounded; lateral process of the fifth thoracic segment very short, flattened antero-posteriorly and obtuse, of the sixth and seventh without spines and rounded; submedian carinæ on all segments of the hind body behind the first exposed thoracic; the telson ornamented dorsally by a crest and curved lines of pits, and having six marginal spines and a pair of anterior lateral carinæ, and on each side three to four submedian teeth, eight intermediate, and one lateral.

General description.—All the specimens of this species seen so far are small. The carapace is rather short, being 0.22 of the total length and seventeen-eighteenths of the greatest width of the abdomen. The greatest width of the carapace is about 0.77 of its length. The telson on the other hand is relatively large and is broader than long, its length being about 0.16 the total length and 0.92 of its width at the base.

The carinæ on the rostrum (fig. 11) are small, but can be made out distinctly with a lens. In the anterior fourth of the carapace the median carina is obsolete or completely lost, but the lateral carinæ pass directly into the anterior lateral spines. Each of the four exposed thoracic segments (fig. 12) has four dorsal longitudinal carinæ except the first, which has no submedian ones. The lateral process of the fifth segment is drawn out into a very short obtuse spine that is flattened antero-posteriorly and is connected by a ridge with the short acute ventral spine of the same side. The sixth and seventh segments have on each side a broad, evenly rounded, lateral lobe pointing obliquely a little backward. In front of this on the sixth segment there is a slight projection common to most species of *Squilla*, but on the seventh this projection is somewhat larger and flattened and approaches the condition found in *S. nepa*. The eighth segment possesses a similar lobe. The carinæ of the abdomen, like those of the thorax, are well developed. None of these end in spines on the first, second, and third abdominal segments, while all but the submedian ones do so on the fourth, and all of them on the fifth and sixth. Besides the six dorsal spines on the sixth segment there is a stout marginal spine in front of each uropod. The telson has a low, sharp crest, ending in a prominent spine and six small carinæ at the bases of the six marginal spines, together with a pair of anterior lateral carinæ in front of the

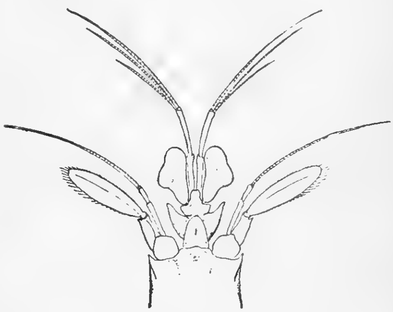


Fig. 11.

CEPHALIC REGION OF SQUILLA PARVA.

Three times natural size.

carinæ of the lateral spines. The rest of the dorsal surface is marked by about ten curved rows of fine shallow pits on each side of the crest. The ventral surface is smooth, except for similar but somewhat fainter lines. The six marginal spines are prominent and acute and are immobile. The median sinus is very deep. The submedian teeth are obtuse, while the intermediate ones are acute.

Returning to the anterior part of the body (fig. 11), the eyes immediately strike one as out of keeping with the other characters, for while the corneal part of the eye is flattened and set obliquely to the peduncle, it is relatively small, the corneal axis being only about four-fifths as long as the peduncular one. The ophthalmic segment is emarginate in front. The first antennæ are about half as long as the body, while the second pair are not quite half as long as the first. The antennary scale is about half as long as the carapace. The carpus of the raptorial claw has on its anterior edge a longitudinal crest, the distal extremity of which is an acute angle, and beyond this there is a small blunt tubercle. The outer (posterior) edge of the dactylus is a compound curve, being slightly sinuate near its base, but there is no basal tubercle. The six teeth are well developed and progressively longer toward the distal extremity. The appendages of the walking legs are linear. The first joint of the exopodite of the uropod is much longer than the second, and bears eight or nine movable spines. The inner margin of the basal prolongation of the uropod is serrated, and there is a large rounded lobe on the outer side of the inner spine.

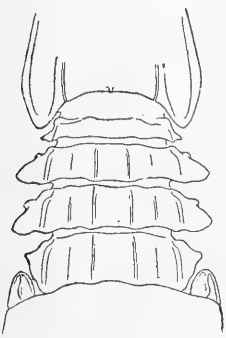


Fig. 12.

EXPOSED THORACIC SEGMENTS OF SQUILLA PARVA.

Four times natural size

Color.—The alcoholic specimens have the body covered with a mottled pattern of dark pigment cells.

Size.—The length of the largest specimen in the collection is 4.15 cm.

Locality.—The collection contains six males and one female collected by the *Albatross* in March, 1888, from the stations not over 13 miles apart in the Bay of Panama where the depth was from 7 to 16 fathoms, and the bottom green mud (Nos. 18477–18479, U.S.N.M.). There is also one poorly preserved specimen from off Manzanillo, Mexico (No. 18480, U.S.N.M.), that seems to belong to this species although the telson is somewhat different from the Panama specimens.

SQUILLA PRASINOLINEATA (Dana?) Miers.

Squilla prasinolineata, ? DANA, Crust. U. S. Expl. Exped., XIII, p. 620, 1852.—MIERS, Ann. and Mag. Nat. Hist. (5) v, p. 19, 1880.

A specimen in the collection (No. 11290, U.S.N.M.) corresponds pretty closely to Miers's description of a specimen that he doubtfully refers to Dana's species of this name. Unfortunately the source of this

specimen is not recorded. According to Ives (1891) this species should be described under a new name for he regards *S. prasinolineata*, Dana, as identical with *S. dufresnii* (Leach) Miers, the first name having the priority. He records (1891) a specimen corresponding to Miers's description of *S. dufresnii* from the coast of Yucatan.

SQUILLA MANTOIDEA, Bigelow.

Squilla mantoidea, BIGELOW, Johns Hopkins Univ. Circ. 106, p. 101, 1893.

Diagnosis.—Eyes triangular, but with the corneal axis at right angles to the peduncular one; dactylus of raptorial claw with six teeth, outer margin not sinuate; rostrum subquadrate, carinate; carapace with five carinæ, the median one bifurcated, and with strong anterior lateral spines; lateral spine of the fifth thoracic segment short, straight, acute, and flattened obliquely, lateral processes of the next two segments strongly produced and acute; submedian carinæ on thoracic and abdominal segments without spines, except the sixth abdominal; telson with a crest and a long ventral keel, twelve or more lines of pits on each side, six marginal spines; denticles 5–6, 11–12, and 1.

General description.—The collection contains but a single specimen of this species, a female from Borneo. Judging only by the published descriptions of *S. mantis* one would refer this specimen to that species, but on comparing it with specimens from the Mediterranean it is seen at once to be specifically distinct.

The body is compact and broad and the carinæ are all well marked. The greatest width of the abdomen equals the length of the carapace, which makes up nearly one-fourth of the total length of the body. The telson is one-sixth of the total length, and its width is $1\frac{1}{4}$ times its length. The rostrum is four-fifths as wide as it is long; it is broadly rounded in front, with nearly parallel sides, and has well-marked marginal and median carinæ.

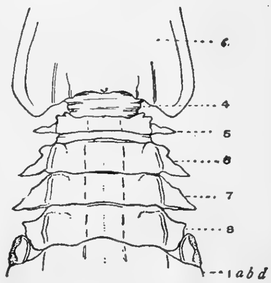


Fig. 13.

EXPOSED THORACIC SEGMENTS OF SQUILLA MANTOIDEA.

Natural size.

4-8.—Fourth to eighth thoracic segments.
1 *abd*.—First abdominal segments.
c.—Carapace.

The carapace is narrowed anteriorly; its smallest diameter being a little more than half the greater, which is a little less than four-sevenths of its length. The five carinæ and the cervical suture are well marked. The median carina incloses a narrow oval area in its anterior quarter. The lateral carinæ are continued into prominent spines that are a little way in from the anterior lateral angles. The posterior lateral lobes are prominent, but are not distinctly angled. The lateral spines of the first exposed thoracic segment (fig. 13) resemble those of *S. mantis*, being straight and acute, but they are small and flattened obliquely. The

ventral pair are large and triangular. The lateral spines of the next two segments are longer than in *S. mantis* and acute, and on the first one there is a small additional anterior lobe. The submedian carinæ are well marked, and the first five abdominal segments have eight carinæ, all of which end in spines except the submedian ones and the intermediate of the first two segments. The sixth segment has six carinæ ending in spines and a spine on the anterior side of each uropod. The telson is quite different from that of *S. mantis*. The crest is low and narrow, and ends in a spine. The general surface of the telson is smooth except for eight or ten lines of very small, shallow pits, arranged symmetrically on each side of the median line. It has a rather long ventral keel. There are six marginal spines, rather long and slender, and with basal carinæ. The anterior lateral carinæ also end in a small projecting angle. There is scarcely any elevation at the bases of the denticles, while in *S. mantis* there is a distinct ridge bordering the telson in both sexes. Another difference of importance between these two species is in the eyes. In *S. mantoidea*, while the corneal axis is longer than the peduncular one (6:5), it is unlike *S. mantis* in being transverse instead of oblique, giving the eye a very different shape (fig. 14). The antennæ are rather long, the first three segments equaling the carapace in length. The second antennæ only reach a little way beyond the second joint of the first. The antennary scale is a little over six-tenths the length of the carapace. The raptorial claw is long, when folded reaching back as far as the median posterior edge of the carapace, and is more slender than in *S. mantis*. The antepenultimate joint has but one spine, not two. The dactylus is not sinuate on its outer margin, and the distal ones of the six teeth are very long, much longer than the proximal ones, the length decreasing gradually towards the base of the dactylus. The appendages of the walking legs are linear. The inner basal spine of the uropod is twice as long as the outer one, bears a small lobe on its outer margin and is finely serrated on its inner margin. The distal joint of the exopodite is shorter than the proximal one, being ten-thirteenths of its length when measured on its ventral side, while in *S. mantis* the two joints are equal, measured in the same way. The proximal joint bears eight movable spines.

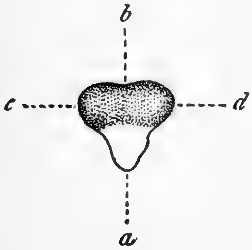


Fig. 14.

EYE OF SQUILLA MANTOIDEA.

Twice natural size.
ab.—Peduncular axis.
cd.—Corneal axis.

Color.—The alcoholic specimen shows a dark band on the rostrum, three irregular bands on the carapace, and a band on each segment of the hind body except the sixth abdominal. The posterior half of each uropod is black.

Size.—Length of body, 12 cm.

Locality.—There is in the collection a single female from Borneo, purchased of H. A. Ward, No. 18504. U.S.N.M.

SQUILLA ACULEATA, Bigelow.

Squilla aculeata, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 101, 1893.

Diagnosis.—A species having small but triangular eyes, the corneal axis not exceeding the peduncular and nearly transverse; the dactyli of the raptorial claws very strong, with six teeth; a broad rostrum provided with median and lateral carinæ; five carinæ upon the carapace, the lateral ones passing into the anterior lateral spines, and the posterior lateral margins angled; the lateral processes of the first exposed thoracic segment curved forward and acute, of the second and third acuminate; submedian carinæ present on all the segments of the hind body except the first exposed thoracic, but not ending in spines except on the sixth abdominal, all the other carinæ ending in spines on the third, fourth, and fifth segments, and the lateral ones on the first and second; in the male a thickened crest on the telson ending in a small spine, the surface of the telson on each side marked with curved lines of pits, six marginal spines, of which the submedian and intermediate are very large and curved, and, like the lateral ones, have thickened basal carinæ, and between these three to four submedian teeth, five to seven intermediate, and one lateral tooth, no trace of a ventral keel; the inner spine on the basal prolongation of the uropod much longer than the outer and with a rounded lobe on the outer side near its base.

General description.—At first sight this species appears to be identical with *S. empusa* except for its smaller eyes and the heightened topography of its telson, but a careful comparison of the specimens reveals many minor points of difference. I shall base the following description upon a large male specimen from Chile and afterward compare with it a small female from Panama.

The body is strongly and compactly put together. The carapace is nearly 0.22 of the total length of the body and 0.97 of the greatest width of the abdomen. The width of the carapace is about 0.83 of its length. The telson takes up 0.17 of the total length of the animal, and its width at the base is 1.06 times its length.

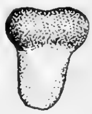


Fig. 15.

EYE OF SQUILLA ACULEATA.

Twice natural size.

The eyes (fig. 15) are strikingly small, their width (length of the corneal axis) being 0.033 of the length of the body, but this is very nearly equal to the length of the peduncular axis, and the eye is flattened in the usual way and is subtriangular. The ophthalmic segment is rounded and entire in front, and the processes at the bases of the eyes are short and rounded. The processes on the antennary segment are also rounded. The first antennæ appear to be about two-fifths the length of the body, while the second pair reach to the end of the third joints of the first pair. The antennary scales are

of about the usual size—a little more than half the length of the carapace. The raptorial claws are rather short when folded, only reaching back as far as the angle on the side of the carapace. The carpus has no spines, but is armed with a sharp crest that ends distally in a rounded angle. The outer edge of the dactylus describes a curve which if slightly changed might become either a simple or a compound curve.

The rostrum is nearly as broad at the tip as it is at the base, and the lateral and median carinæ are well marked. The median carina of the carapace is bifurcated in front but is only faintly marked in this region. The angle on each posterior lobe is well marked. The ventral spines on the first exposed (fifth) thoracic segment are strong, sharp and pointed obliquely forward, and there is a low ridge running from each one to the nearest marginal process. There is a small projection on the second segment in front of each lateral lobe. The submedian carinæ are nowhere very prominent, but the others on the abdomen become more and more pronounced toward the telson. The sixth segment has a small spine on the same side in front of the uropod.

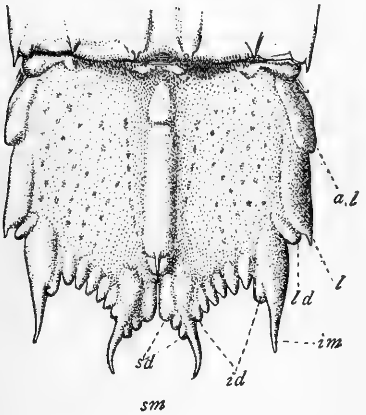


Fig. 16.

TELSON OF SQUILLA ACULEATA.

Male. Two-thirds natural size.
al.—Anterior lateral angle and carina.
l., *im.*, *sm.*—Lateral, intermediate, and submedian spines, each with a basal carina.
ld., *id.*, *sd.*—Lateral, intermediate, and submedian denticles.

The long submedian and intermediate spines, curved like the horns of a cow together with the thickenings at the bases of the spines and teeth, give the telson (fig. 16) a very striking appearance. There is a separate elevation at the margin corresponding to each denticle and spine, and there is also a distinct pair of anterior lateral carinæ. The general surface of the telson is unusually smooth, but the pits are unusually well defined. They are arranged in about eight rows. The ventral surface is perfectly smooth except for a corresponding series of pits and a small carina on each side running in a short way from the extreme anterior lateral angle. The denticles are all blunt. The uropods present nothing remarkable except that the lobe on the inner spine of the basal projection is a little nearer the base than usual. The inner margin of the projection is bluntly serrated and the second joint of the exopodite is about two-thirds the length of the first joint. The latter bears eight movable spines.

S. empusa, Say, differs from this specimen in having wider eyes (0.043 times total length); the processes on the antennary segment acute; two small spines on the anterior edge of the carpus of the raptorial

claw; the outer edge of the dactylus, a compound curve, and the median carina of the carapace distinct in front. The lateral processes of the sixth and seventh thoracic segments in *S. empusa* are acute, but hardly acuminate, and the submedian carinæ of the fourth and fifth abdominal segments end in spines. The marginal spines of the telson are also not unusually long, and on the ventral surface there is a distinct postanal carina, or keel; while the two joints of the exopodite of the uropod are of equal length, and there is no lobe on the inner spine of the basal projection.

The small female specimen from Panama, referred to above, occupies an intermediate position between the larger specimen I have just described and *S. empusa*. The eyes are the same size as in the latter, relatively to the length of the body, but the ratio of the length of the peduncle to that of the corneal axis is greater than in *S. empusa* and like that of the type specimen. The outer edge of the raptorial dactylus is a compound curve and the dorsal surface and the margin of the telson closely resemble the condition found in *S. empusa*, but in all other respects this specimen agrees with the type. As the females and the young of both sexes are known to differ from the mature males in several species of *Squilla*, I think it most probable that this small specimen represents an immature condition of the larger one.

Color.—The larger specimen has completely faded, but the smaller one has a symmetrical mottled arrangement of dark pigment cells.

Size.—Length of body, 15 cm. and 6.85 cm.

Locality.—The large specimen was collected by W. H. Jones, U. S. Navy, then on board the U. S. S. *Wachusett* at Iquique, Chile (No. 11198, U.S.N.M.). The smaller one was taken at Panama and was purchased from H. A. Ward (No. 15626, U.S.N.M.).

SQUILLA EMPUSA, Say.

Squilla empusa, SAY, Journ. Acad. Nat. Sci. Phila., I, p. 250, 1818.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 525, 1837.—DE KAY, New York Fauna, VI, Crust., p. 32, 1844.—MIERS, Ann. and Mag. Nat. Hist. (5) V, p. 23, 1880.—BROOKS, Voyage of the *Challenger,* XVI, p. 25, 1886.

Diagnosis.—Eyes triangular and with oblique corneal axis equal to peduncular axis; six teeth on the dactylus of the raptorial claw, the outer edge of the dactylus sinuate; rostrum variable, generally a little longer than broad, subquadrate or hemiellipsoidal and possessing lateral and median carinæ; carapace with five carinæ, the median one bifurcated, the lateral ones produced into large anterior lateral spines, the posterior lateral margins angled; the fifth thoracic segment with separate ventral and lateral spines, the latter being slightly curved forward and acute; the lateral processes of the next two segments strongly produced and acute or mucronate; eight carinæ on the first five abdominal segments; telson with crest and curved lines of pits, six marginal spines and eight basal carinæ and on each side three to four submedian,

six to nine intermediate, and one lateral denticle; the carinæ and the elevations at the bases of the denticles always distinct; never any thickening of the margin of the telson or of the abdomen in the males.

Remarks.—Say's description of this species is very brief, and like Gibbes, his conception of *S. mantis* seems to have been derived from a figure given by Herbst that was, I think, intended to represent *S. nepa*, Latreille. His description is colored by this idea. De Kay's figure is very poor, but indicates that the outer edge of the dactylus is sinuate.

Miers pointed out that this species is extremely close to *S. mantis*, but may be recognized by the lateral processes of the first exposed thoracic segment being elongated and curved forward, instead of being straight. Brooks has described and figured the first abdominal appendage of the male. All of these authors, however, neglect characters which separate this from closely related species. In order to compare them we need to start with an adequate definition of *S. empusa*, and it is with the hope of supplying this that I have introduced the above diagnosis, founded upon the study of specimens from Beaufort, N. C., preserved at the Johns Hopkins University, and on others from various localities in the National Museum.

This species is so very near to *S. mantis* that Miers was at first inclined to regard it as a mere variety, and it seems to me that this is probably the correct view. Although very slight, there are, however, differences, which are constant in the specimens that I have examined. As stated above, the lateral spine of the first exposed thoracic segment is more curved than in *S. mantis*. The rostrum in full-grown specimens of *S. empusa* is broader in proportion to its length, and the corneal axis of the eye very nearly equals the peduncular one, while in *S. mantis* the corneal axis is about six-fifths the length of the peduncular one. Large specimens of *S. mantis*, of both sexes, have a slight thickening at the margin of the telson that is almost altogether absent in *S. empusa*.

Size.—Length of body of a large specimen, 18 cm.

Locality.—There are specimens in the National Museum from numerous stations between Woods Holl, Mass., and Pensacola, Fla.

SQUILLA MANTIS, Latreille.

Squille mante, DE GEER, Mém. pour servir à l'hist. des Insectes, VII, p. 533, 1778.

Squilla mantis, LATREILLE, Hist. Nat. Crust., VI, p. 278, 1802; Encycl. Méth. Hist. Nat., X, p. 471, 1825.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 21, 1880.

Of this species, common in the Mediterranean, the Museum possesses two males collected by Dr. D. S. Jordan at Venice, Italy (No. 5151, U. S.N.M.), and a male and female from Naples, received from Rev. A. M. Norman (No. 14552, U.S.N.M.).

SQUILLA PANAMENSIS, Bigelow.

Squilla panamensis, BIGELOW, Johns Hopkins Univ. Circ., 88, 1891.

Diagnosis.—Squillæ with large triangular eyes having a slender stalk; six teeth on the dactylus of the raptorial claw; an ovate or ellip-

soidal rostrum with median and marginal carinæ; a carapace having five carinæ, very small spines at the anterior lateral angles and angled at the sides posteriorly; the lateral spines of the fifth thoracic segment curved a little forward and acute, the lateral processes of the next two segments obliquely truncated and subacute; eight carinæ on the abdominal segments, all on the last three of these segments ending in spines; a crest and curved lines of pits on the telson, a long ventral keel, six or eight marginal spines and five submedian, ten to twelve intermediate and one to two lateral teeth; the crest and margin of the telson as well as the lateral margins of the abdomen thickened in the male, the thickening being greatest at the bases of the marginal spines.

General description.—A female specimen of this species is difficult to distinguish from *S. empusa*, Say, but an adult male is easily recognized by the thickenings of the telson and sides of the abdomen, there being no trace of these sexual characters in *S. empusa*. The typical form exhibits other points of difference from that species, which will be mentioned farther on.

The carapace occupies about two-tenths of the total length of the body and is a little longer than the telson, which is about 0.16 or 0.18 of the total length. The width of the telson at its base nearly equals its length and the greatest width of the carapace. The carapace is narrowed in front so that the distance between the anterior lateral angles only slightly exceeds half of the greatest width. The diameter of the body just behind the carapace is less than half the greatest width of the abdomen.

The rostrum is ovate or subtriangular and faintly marked by median and marginal carinæ.

The carapace has five longitudinal carinæ, the median one being bifurcated at each end, so as to inclose a lozenge-shaped area, and the lateral ones ending in a minute spine at each anterior lateral angle.

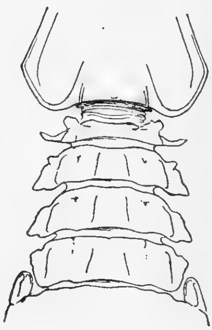


Fig. 17.

THORACIC REGION OF SQUILLA PANAMENSIS.

Natural size.

All segments of the hind body are provided with submedian carinæ, except the fifth thoracic. This segment, fig. 17, has a pair of acute ventral spines, and its lateral spines are acute and slightly curved forward. In my preliminary description of this species (1891) I spoke of the margins of the next two segments as bilobed, which is somewhat misleading, for in the first of them, while there is an anterior lateral process exactly homologous to the one found in *S. nepa*, still it is so small and the posterior process is so much larger, that the term tends to convey a false impression, which I wish to correct. The lateral processes of the second of these segments had better be described as indented or sinuate. In both cases the posterior processes are

rounded and mucronate or subacute in the typical form. All the carinæ on the fourth, fifth and sixth abdominal somites end in spines, and there is a spine in front of the articulation of each uropod. In the first abdominal somite only the marginal carinæ end in spines; the second has spines terminating the lateral carinæ as well as the marginal ones, and the third has also spines on the intermediate ones. There is a very slight median tubercle on all but the first and sixth abdominal segments. In full-grown males the marginal carinæ are thickened. This thickening extends as a broad elevation along the posterior margin and involves the greater part of the lateral carinæ. There is no trace of any such thickening in the females.

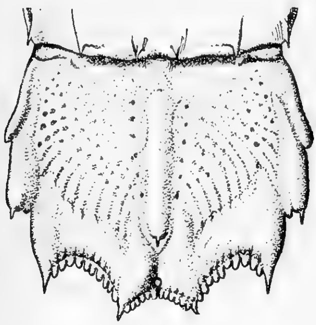


Fig. 18.

TELSON OF SQUILLA PANAMENSIS.

Male. Slightly enlarged.

In the female of the typical form the crest of the telson ends in a small spine, and behind it there is a small tubercle. The six marginal spines are slender and acute and have basal carinæ. There is also a distinct anterior lateral pair of carinæ. The denticles are large and rounded and have smaller elevations at their bases. The dorsal surface is marked on each side by a row of shallow pits, running nearly parallel to the crest and a series of about a dozen curved lines of pits, running outward and backward. The ventral surface has an exactly similar arrangement of these sculpturings. There is also a keel extending about half way from the anus to the median sinus, and there is a pair of lateral carinæ. In full-grown males the crest and the dorsal side of the margin of the telson are very much thickened (fig. 18). The basal elevations of the denticles on the medial side of each carina form with it a continuous ridge, while there is a distinct furrow separating the carina from the elevations on its lateral side. The marginal thickening is greatest at the bases of the spines.

The eyes are broadly triangular. The corneal axis is oblique and about one-fifth longer than the peduncular axis, while it is about five one-hundredths of the total length of the body. The spines at the bases of the eyes are erect and truncated. The first three joints of the first antennæ are about equal in length to the carapace. The second antennæ are about as long as this and the antennary scale is very nearly two-thirds as long. The raptorial claw is strongly developed. The carpus has a series of teeth on its anterior margin. The outer margin of the dactylus is not sinuate and has no tubercle or one that is hardly perceptible near the articulation. The appendages on the walking legs are slightly spatulate or sinuate. The basal prolongation of the uropod is finely serrated on the inner side and the inner spine is twice as long as the outer one, and has a minute lobe on the outer side in the

middle of its length. The terminal joint of the exopodite is about two-thirds the length of the first joint, which bears eight or nine movable spines.

Varieties.—Animals answering to this description appear to be very abundant in the Bay of Panama. There are three other groups of specimens in the collection that are distinct from these, but the differences are so slight that they may all be regarded as varieties of one species. First, there are a number of specimens from off Cape Lobos, Mexico, and from Point San Fermin to Consag Rock, Lower California, that are evidently of the same species as those I have described as *S. panamensis*, but which differ from them in having the lateral spine of the fifth thoracic segment more curved and the anterior lateral carinæ of the telson produced into short spines, so that there are eight marginal spines on the telson. This form may be designated as *variety A*, the Panama form being taken as the type of the species. *Variety B* is represented by a few specimens from the southeast of Tiburon Island, Mexico. It agrees with the first in that the telson has but six marginal spines, while it differs from this and agrees with the last in having a well-marked tooth upon the outer side of the inner spine of the basal prolongation of the uropod, and it differs from both the others in having the proximal segment of the exopodite not longer than the distal segment. The marginal spine of the fifth thoracic segment is large and curved forward into a strongly sickle-shaped, acute process. The margins of the next two segments are rounded on the anterior side and have their points directed farther backward, and are more sharply acute than in the other varieties. This variety is also very different in its color markings, if we may judge from alcoholic material. It is much less like the type than *variety A*, and it may be found eventually to rank as a separate species, for the only male specimens in the collection are very small and immature, so that until adult males have been found we can not tell whether or not this form possesses the characteristic telson of *S. panamensis*.

It is also with some hesitation that I refer to this species, a single young male specimen from off Cape Frio, Brazil. In the shape of its body, the arrangement of pigmented areas in the integument, and the form of its eyes it resembles *S. panamensis* very much, and the edge of the telson appears to have begun to thicken, so it is probably better to regard it as belonging to this species rather than to *S. empusa*. If this view be accepted this specimen will represent a third variety, *C*. It differs from the type in having the rostrum elongated so that it partly covers the ophthalmic segment. The anterior lateral spines of the carapace are longer. The lateral angles of the second and third exposed thoracic segments are longer and more acute. The first abdominal segment carries lateral spines and the second one has intermediate ones. Moreover, there is a good-sized lobe on the outer side of the inner spine of the basal prolongation of the uropod.

Color.—In alcoholic specimens there is a line of dark pigment following both of the longitudinal sutures of the carapace and bordering its anterior margin, except the middle third. The posterior margin of the carapace and of most of the exposed segments of the body are marked each by a dark line. There is also a very dark triangular spot on each side of the telson near the crest. *Variety B* has in addition a large transverse dark spot on the second and fifth abdominal segments and faintly marked transverse bands on the carapace and other segments.

Size.—The largest specimen measures 14 cm. in length.

Locality.—The specimens of the type-form, of which there are a large number of both sexes and of various sizes, were all taken by the *Albatross* in Panama Bay at a depth of between 26 and 47 fathoms (Nos. 18458–18460, U.S.N.M.). Of *Variety A* about 20 specimens were taken off Cape Lobos, Mexico (Nos. 18461, 18462, U.S.N.M.), 2 off Consag Rock, Lower California (Nos. 18465, 18466, U.S.N.M.), 5 off Diggs' Point, (18467, U.S.N.M.), and 10 off Cape San Fermin (Nos. 18463, 18464, U.S. N.M.). The depth varied from 12 to 76 fathoms. Three females and two young males of *Variety B* were taken in 29 fathoms of water at station 3014 southeast of Tiburon Island, Mexico (No. 18468, U.S.N.M.). A single male specimen of *Variety C* was captured off Cape Frio, Brazil, in 59 fathoms (No. 18469, U.S.N.M.).

SQUILLA INTERMEDIA, Bigelow.

Squilla intermedia, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 102, 1893.

Diagnosis.—A *Squilla* having very large nearly T-shaped eyes; very large and strong raptorial claws, with six teeth upon the dactylus; the rostrum narrowed in front and provided with well-marked median and lateral carinæ; five strong carinæ on the carapace, the median one bifurcated in front and behind, and the lateral one ending in spines at the anterior lateral angles, posterior lateral margin angled; the lateral margin of the fifth thoracic segment produced into a strongly sickle-shaped acute spine, of the sixth and seventh obliquely truncated and very acute; eight prominent carinæ on the abdominal segments all ending in spines except the submedian of the first four segments; a low crest on the telson ending in a small spine, a post-anal keel without a spine, the dorsal and ventral surfaces of the telson marked by numerous curved lines of very fine pits, six marginal spines, and four to six submedian denticles, ten to thirteen intermediate and one lateral one; the crest and dorsal side of the margin of the telson very much thickened in the male, the marginal thickening being continuous between the intermediate spines.

General description.—This species stands in an intermediate position between *S. panamensis* and *S. biformis*. The body is compactly and strongly put together. The exposed thoracic region is about two-thirds the length of the carapace. The latter occupies a little less than one-fourth the total length of the body, while the telson is just one-fifth the total length. The length of the telson is the same as its width at the

base, and also equals the greatest width of the carapace. The greatest width of the abdomen is about one-tenth greater than the length of the carapace. The eyes are of somewhat different proportions in the two specimens before me, for in the female the corneal axis exceeds the peduncular one by 0.43 of its length and is 0.068 times the length of the body, while in the male the corneal axis exceeds the other by only 0.15 and is 0.060 times the length of the body.

The rostrum is narrowed and rounded in front, and besides the marginal carinæ has a prominent median carina in its anterior half. The carinæ on the carapace are very well marked, and the cervical suture is very distinct. At each of the anterior lateral angles the lateral carina is continued into a strong projecting spine. There is a marked external angle on each posterior lateral lobe. Submedian and lateral carinæ are present on all the exposed thoracic segments. The first one has a strong, acute pair of ventral spines, besides the sickle-shaped lateral spines. The lateral processes of the next two segments resemble those of *S. biformis*, but are more acute. The abdominal carinæ are very prominent and the spines are strong and sharp. There is a small spine in front of the articulation of the uropod. In the male the marginal carinæ are very slightly thickened. The telson of the female is very similar to that of the female *S. biformis*. The crest rises gradually from the general surface, which is smooth except for about a dozen curved lines of very shallow pits, the lines branching at the periphery. The carinæ at the bases of the marginal spines are small and low. There is also a pair of anterior lateral carinæ separated from the posterior pair by only a slight dorsal notch. There are slight elevations at the bases of the denticles. This specimen differs from a female of *S. biformis* in having fewer and larger denticles on the telson, larger marginal spines, a higher crest, and no spine on the short ventral keel. In the male (fig. 19) the crest and the margin of the telson are much thickened on the dorsal side. But it differs from the male *S. biformis* in having the marginal ridge interrupted in two places on each side. One of these marks the end of the anterior lateral carina, and the other is just behind the lateral denticle. Except for these, the ridge is smooth and continuous and therefore quite different from the condition found in *S. panamensis*.

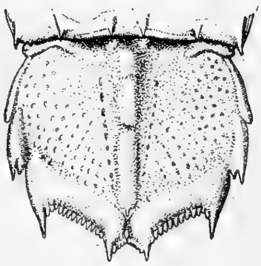


Fig. 19.

TELSON OF SQUILLA INTERMEDIA.

Male. Slightly enlarged.

The basal prolongation of the uropod is finely serrated on its inner margin, and the inner spine has a rounded lobe in the middle of its outer side. The proximal joint of the exopodite is but a little longer than the distal one and bears seven movable spines. The eyes are large

and broadly T-shaped, especially in the female. The male has rounded processes at the bases of the eyes, while in the female they are acute. The ophthalmic segment is emarginate in front. The next segment is completely covered by the rostrum and bears a pair of acute spines. The first three joints of the first antennæ are longer than the carapace. The second antennæ are about as long as the carapace, and the antennary scales are three-fourths as long. The raptorial claw is so long that when folded it extends as far back as the most posterior point of the carapace. There are two short spines on the outer margin of the carpus. The pectinations on the inner margin of the manus have an undulating outline. The dactylus has six strong teeth. It is angled near the articulation, but from the angle to the tip of the terminal tooth its outer edge forms a simple curve. The appendages on the three posterior pairs of thoracic legs are linear or narrowly spatulate.

Size.—Length of the largest specimen, 10.5 cm.

Locality.—There are but two specimens in the collection, both collected by the *Albatross.* One, a male, was taken in 1885 at station 2378, in the Gulf of Mexico, near the delta of the Mississippi (No. 9658, U.S. N.M.). The other, a female, was taken in 1886 at station 2655, in the Atlantic, north of Little Bahama Bank (No. 11543, U.S.N.M.).

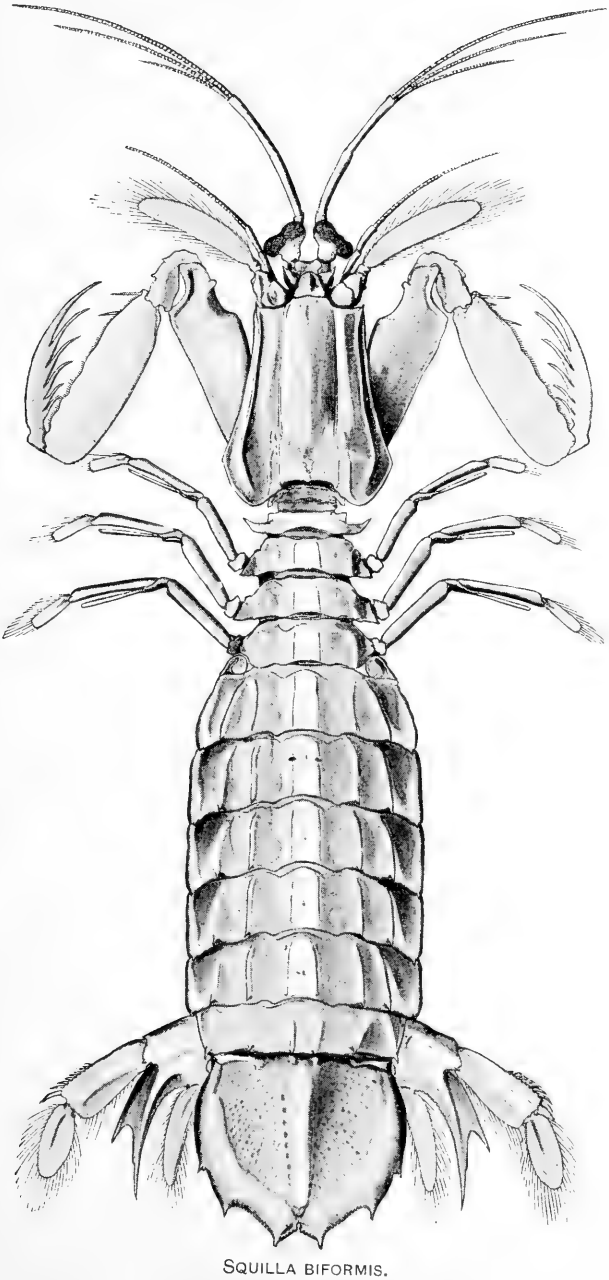
SQUILLA BIFORMIS, Bigelow.

Plate XXI.

Squilla biformis, BIGELOW, Johns Hopkins Univ. Circ., 88, 1891.

Diagnosis.—Eyes large, subtriangular or nearly T-shaped; dactylus of the raptorial claw with six teeth; rostrum ovate, with median and marginal carinæ; carapace provided with five well-marked carinæ, anterior lateral angles produced into small acute spines, posterior lobes angled at the sides; lateral spines of the first exposed thoracic segment strong, well curved forward, and acute, lateral processes of the next two segments obliquely truncated and acute; eight prominent carinæ on the first five abdominal segments; telson with a crest, a short ventral keel produced into a stout spine directed backward, and the general surface marked by many symmetrically curved lines of shallow pits, the dorsal surface in males elevated into a continuous smooth thickening around the entire free border; in females no elevations at the bases of the denticles and very small carinæ at the bases of the six marginal spines; five to seven submedian denticles, 15 to 19 intermediate, and one lateral, all small.

General description.—This is a large species, about 17 cm. long. The carapace (pl. XXI) equals in length the exposed thoracic segments and the telson measured from its base to the tip of the submedian spines, and is somewhat less than half as long as the first six abdominal segments. The body widens gradually from the posterior margin of the



SQUILLA BIFORMIS.

Male. About three-fourths natural size.

carapace to the second abdominal segment, then keeps about the same width back to the telson.

The rostrum is as broad as it is long and is broadly rounded in outline anteriorly. It extends over the first antennary segment. The median and marginal carinæ are well marked, the former extending, however, only along the first half of the rostrum. The length of the carapace equals nearly the posterior width and is about twice the width between the anterior lateral angles. All five carinæ are well marked. The median is bifurcated fore and aft, and it and the intermediate are interrupted by the transverse suture. There is a median tubercle on the posterior margin. The anterior lateral angles are rounded except at the point of termination of the intermediate carina, where a sharp spine arises abruptly. The posterior lateral lobes are obtusely angled laterally.

The exposed thoracic segments are provided with well-marked submedian and intermediate carinæ. The ventral spine of the first exposed segment is obliquely flattened and acuminate, the lateral one is flattened dorso-ventrally, curved forward, and acute. The lateral margins of the next two segments are obliquely truncated and acute.

The first five abdominal segments have submedian, intermediate, lateral, and marginal dorsal carinæ. The sixth has all but the latter, and the second, third, fourth, and fifth have double median tubercles. The marginal and lateral carinæ of the first abdominal somite end posteriorly in spines. This is true of all but the submedian in the second, third, and fourth, and in the fifth and sixth they all end in spines.

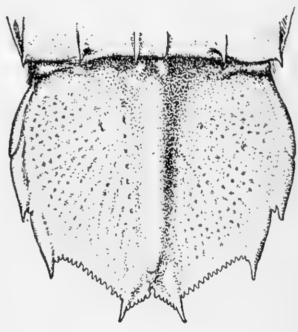


Fig. 20.

TELSON OF SQUILLA BIFORMIS.

Female. Slightly enlarged.

The telson is a little shorter than broad and generally rounded in outline. There are six relatively small marginal spines which in the female (fig. 20) are continued into very slightly elevated carinæ. The anterior lateral carinæ are distinct, but not prolonged into spines. The submedian spines are divergent. Between each submedian spine and the shallow median sinus there are five or seven blunt teeth. Between a submedian and an intermediate there are 15 or 17, and there is one between the intermediate and lateral spines. The crest is rather broad and terminates in a very small spine. On the ventral surface there is a short prominent keel, which is drawn out into a stout and sharp spine, pointed directly backward. Both dorsal and ventral surfaces are marked by numerous symmetrical curved lines of shallow pits, and the dorsal surface is slightly roughened between them. In the adult male (pl. XXI) the crest is thickened and whole margin of the telson is very much swollen on the dorsal side, so that all the carinæ run together.

The eyes are very large and nearly T-shaped. The corneal part is very prominent, is more than twice as long as the stalk, and is divided into two parts by a slight groove. The anterior process of the ocular segment is emarginate. The lateral processes are flat, broad, and obtuse. The first antennæ are rather long, about the length of the last five abdominal segments. The spines of the corresponding segment are short, straight, and acute. The second antennæ reach a little beyond the base of the flagella of the first pair. The antennary scale is large. The raptorial claw is strong. The dactylus has six long claws. The pectinations on the manus are in a slightly undulating line. The carpus has two or three short processes on the anterior edge. The appendages to the thoracic appendages are linear. The inner spine of the basal prolongation of the uropod is more than twice as long as the outer one, and has a very small tooth on its outer side, about the middle of its length, and the inner edge is serrated. The endopodite has its sides nearly parallel. The terminal joint of the exopodite is nearly three-fourths the length of the first joint. On the outer edge of this joint there are eight to ten movable spines, usually nine. In fully mature specimens the difference between the sexes is very marked. In the adult male, besides the thickening of the crest and the margins of the telson, the marginal carinæ of the other abdominal somites are very broad and thick, and each one is connected along the posterior margin of the somite with the lateral carina, which is a little broader than in the female. The general shape of the abdomen differs in the two sexes, the first, second, and third segments being much wider in the male (pl. XXI).

The young males in the collection (e. g., two 5.4 and 7.4 cm. long, respectively) are in general like mature females, but differ in certain peculiarities of the telson. The crest is sharp and ends in a prominent spine. The marginal spines are relatively much larger than in the adult. Between the submedian spines and the median sinus there are next the spine two or three ordinary teeth, then for the rest of the distance to the sinus it appears as if the teeth were fused and their outer edges produced into a number of very fine teeth. This is most marked in the younger specimens. In a nearly full-grown female the pair of teeth next the sinus were found to possess similarly serrated borders.

Color.—The alcoholic specimens have no characteristic coloring.

Size.—The largest specimen is a male 17 cm. long.

Locality.—The *Albatross*, in 1889, captured three large males, two small ones, and two large females, in the Gulf of California, off La Paz Harbor, at a depth of 112 fathoms (No. 18493, U.S.N.M.). The *Albatross* expedition of 1891, under the direction of Dr. Alexander Agassiz, took 66 specimens of both sexes and various sizes at stations 3389, 3391, 3396, and 3397 (No. 18474, U.S.N.M.), in Panama Bay, the depth varying from 85 to 259 fathoms.

SQUILLA RAPHIDEA, Fabricius.

Squilla arenaria marina, SEBA, Thesaurus, III, p. 50, 1758.
Squilla raphideá, FABRICIUS, Ent. Syst. Suppl., p. 416, 1798.—LATREILLE, Encycl. Méth., X, p. 471, 1825.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 524, 1837.—WHITE, List Crust. Brit. Mus., p. 84, 1847.—MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 27, 1880.
Squilla mantis, var. *B. major*, LAMARCK, Hist. Anim. sans Vert., V, p. 187, 1818.
Squilla harpax, DE HAAN, Fauna Japon. Crust., p. 222, 1849.

The Museum contains two specimens, one from Hongkong, China, collected by W. Stimpson on the North Pacific Exploring Expedition (No. 2108, U.S.N.M.), the other collected by the U. S. S. *Palos*, no locality given (No. 5146, U.S.N.M.).

SQUILLA NEPA, Latreille.

? *Cancer* (*mantis*) *digitalis*, HERBST, Naturg. Krabben und Krebse, p. 93, pl. XXXIII, fig. 1, 1796.
Squilla nepa, LATREILLE, Encycl. Méth. Hist. Nat., X, p. 471, 1825.—MILNE-EDWARDS, Hist. Nat. Crust., II, p. 522, 1837.—BERTHOLD, Abhandl. d. kön. Gesellsch. d. Wiss. Göttingen, III, 1845.—DE HAAN, Siebold's Fauna Japonica, 1850.—BIGELOW, Johns Hopkins Univ. Circ., 106, p. 102, 1893.
? *Squilla nepa*, HELLER, Reise der Novara, Crust., p. 124, 1865.—MIERS, Cat. New Zeal. Crust., p. 89, 1876; Ann. and Mag. Nat. Hist. (5), V, p. 25, 1880.
? *Squilla oratoria*, DANA, Crust. U. S. Expl. Exped., XIII, i, p. 621, 1852.
? *Squilla Edwardsii*, GIEBEL, Zeitschr. f. d. gesammt. Naturwiss., XVIII, p. 319, 1861.
? *Squilla Massavensis*, KOSSMANN, Zool. Ergeb. einer Reise in dem Küsteng. des Rothen Meeres, II, p. 99, 1880.

Diagnosis.—A *Squilla* with very small eyes, the corneal axis being about three-fourths the length of the peduncular one and at right angles to it, and 0.029 times the length of the body; the dactylus of each raptorial claw deeply sinuate on its outer margin and provided on its inner margin with six teeth, including the terminal one; an ovate rostrum with marginal carinæ and a small median tubercle; five carinæ on the carapace, the median one bifurcated for nearly or more than half its length; spines at the anterior lateral angles of the carapace extending farther forward than the suture between the carapace and rostrum, the posterior lateral angles being evenly rounded; no ventral spines on first exposed thoracic segment but instead an additional lateral process, making two on each side, the anterior one being curved forward and acute and the posterior one much smaller, narrow, straight, and blunt; the lateral margins of the next two segments bilobed, the two lobes on the first one being of equal length and rounded or subacute, but the posterior one broader than the other, while on the second one the anterior lobe is very much the smaller; eight submedian carinæ on all the segments of the hind body except the first exposed thoracic; a crest and a keel on the telson and symmetrical lines of pits on each side; six marginal spines and eight basal carinæ and between the former two to three submedian, eight to ten intermediate, and one lateral denticle.

Locality.—The collection contains two female specimens. One of these is from Singapore (No. 2120, U.S.N.M.), and was collected by J. D. Dana while with the U. S. Exploring Expedition under Wilkes. The original label bears the name "*Squilla rhetorica*, S. & M." The other one is labeled Borneo (No. 15627, U.S.N.M.), and the name of the collector is not given.

Remarks on synonymy.—In the collection of the National Museum I have found two sets of specimens, either of which corresponds perfectly with the description of *Squilla nepa*, Latreille, as given by Miers, but which are evidently distinct. The most striking difference is in the eyes. Of one set, these are small and of the *Chloridella* type; of the other, they are large and of the type found in *S. mantis*. Further comparison shows other points of difference. The question immediately presents itself, which of these is the form that was originally described as *Squilla nepa?* and this suggests the further question, is the other form a new species, or has it been described under one of the several names now regarded as synonymous with *nepa?*

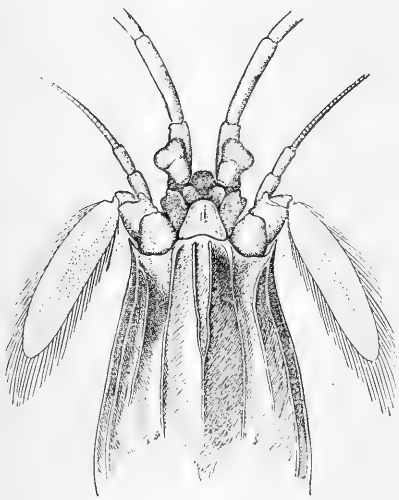


Fig. 21.

CEPHALIC REGION OF SQUILLA NEPA.

Slightly enlarged.

Latreille's original description of *Squilla nepa* is based on a single specimen from China, is very short, and applies equally well to either of our forms; but he refers to the figure given by Herbst (1796) of *Squilla digitalis*, and in this the animal is represented as having small eyes, the corneal axis not exceeding the peduncular one. This would indicate that the original *S. nepa* was our small-eyed form. Miers says, to be sure, that this figure seems intended for *S. mantis*, but this does not seem to me to be true. Although Herbst gives *Squilla mantis*, De Geer, etc., as a synonym of his "*Cancer* (*mantis*) *digitalis*," it appears to me that he had chiefly in mind the East Indian form, and took it for granted that the Mediterranean one was the same, for in his figure (Tab. 33, fig. 1) the margins of the thoracic segments are bilobed, thus plainly showing the chief characteristic that separates the two species, and in the text he says:

Das Vaterland ist Ostindien; auch findet man ihn häufig im Adriatischen Meere und im Liburnischen Meerbusen, woselbst er Canochia genannt wird.

Except in a few points, however, the description given by Herbst

would apply equally well to any *Squilla* related to *S. mantis*, and it seems to be the general opinion of the zoologists that followed him that his figures are unreliable. We may, therefore, follow the general usage and give to Latreille the credit of first clearly distinguishing the Mediterranean from the Indian species.

Turning now our attention to *S. oratoria*, De Haan, the most prominent synonym of *S. nepa* given by Miers, we find that Heller (1868) separates forms under these two names, but as noted by Miers, does not give his reasons for doing so. Dana (1852) reports this species from Singapore, but his short description contains nothing to distinguish it from *S. nepa*. De Haan's original description (1850) is a short one in Latin and contains nothing that is not also true of *S. nepa*. In his analytical key he separates the two by the difference in the length of the anterior lateral angles of the carapace. So far Miers appears to be right in regarding the two as synonyms, but De Haan's figure differs from the one of Herbst referred to by Latreille in representing the animal as having large triangular eyes. Moreover, De Haan gives *S. affinis*, Berthold, as a synonym of *S. oratoria* and when we refer to Berthold's paper (1845) we find what we were seeking, a clear distinction between the large-eyed and small-eyed forms of *S. nepa*.

Berthold founded his species, *S. affinis*, upon some specimens that he purchased from a ship that had been to China. In his museum he found an old specimen marked *S. digitalis* that corresponded to the descriptions of *S. nepa* given by Latreille and by Milne-Edwards. Comparing the two he found the following differences:

Squilla affinis, BERTHOLD.	*Squilla nepa*, LATREILLE.
The cornea measures obliquely $2\frac{1}{2}'''$.	Only $1\frac{1}{2}'''$.
The upper end of the peduncle reaches nearly to the upper end of the cornea so that the latter is placed obliquely above or below the peduncle.	The upper end of the peduncle hardly reaches any farther forward than the other, so that the cornea is placed directly in front of the peduncle.
The rostrum has an upturned outer margin.	The rostrum has no such upturned border. (See marginal carina shown in fig. 21).
The anterior bifurcation of the median carina of the carapace reaches backward only one-fifth of its length.	This bifurcation reaches backward nearly half the length of the carapace.
The anterior lateral angles of the carapace do not extend beyond its anterior frontal border.	These angles are strongly produced so that they extend beyond this border.
The denticles on the telson are swollen and are arranged obliquely anterior posteriorly.	The denticles have no swollen elevation and point directly backward.
The whole body is thicker, relatively to its length broader and higher.	The body is more slender, less high and broad.
The last joint of the raptorial claw is slightly bent, but not sinuate.	The last joint of the raptorial claw has the proximal half of its outer margin strongly sinuate.

Both sets of my specimens have rostra with carinated margins, and I fail to find any essential differences between them in the denticles on

the telson or in the general proportions of the body. Otherwise, the distinguishing characters given by Berthold hold for my specimens and I am convinced that they represent two distinct species. As Berthold was the first to separate these species we should undoubtedly follow his nomenclature, regarding the small-eyed form as *S. nepa*, Latreille, and giving his name *S. affinis* to the other. Berthold's description of the latter is very complete, is accompanied by measurements and figures, and was published five years before de Haan's. I can not see that de Haan had any warrant for replacing Berthold's name for this species by one of his own, and the latter should be dropped.

The similarities and differences between these two species as exhibited in the collection before me are expressed briefly in the definition given above and in the one which follows.

SQUILLA AFFINIS, Berthold.

Squilla affinis, BERTHOLD, Abhandl. kön. Gesellsch. Wiss. Göttingen, III, p. 26, 1845.—BIGELOW, Johns Hopkins Univ. Circ., 106, p. 102, 1893.
Squilla oratoria, DE HAAN, Siebold's Fauna Japon. Crust., p. 223, 1850.
? *Squilla oratoria*, HELLER, Reise der Novara, Crust., p. 124, 1865.
? *Squilla nepa*, MIERS, Ann. and Mag. Nat. Hist. (5), V, p. 25, 1880.
Squilla nepa, BROOKS, Voy. of the *Challenger*, XVI, ii, p. 25, 1886.

Diagnosis.—A *Squilla* with large triangular eyes, the corneal axis being oblique and as long as or usually longer than the peduncular one and 0.05 times the length of the body; the outer margin of the dactylus of the raptorial claw not sinuate or only slightly so; six teeth on the dactylus; the rostrum slightly truncated and provided with marginal carinæ and a median tubercle; five carinæ on the carapace, the median one not bifurcated for more than one-fourth its length, and the lateral ones continued into the anterior lateral spines, which do not reach as far forward as the suture between the rostrum and carapace, the posterior lateral angles evenly rounded; no ventral spines on the first exposed thoracic segment, its lateral processes and those of the next two segments bilobed as in *S. nepa;* submedian carinæ present on all except the first segments of the hind body; crest, keel, and symmetrical lines of pits on the telson and six marginal spines, eight basal carinæ, and between the former four to five submedian, seven to nine intermediate, and one lateral denticle.*

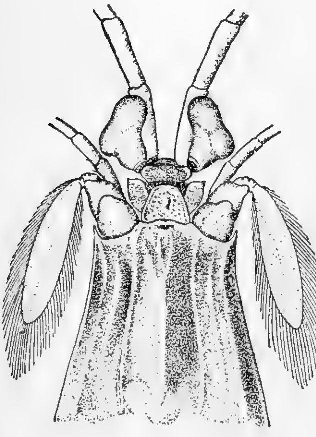


Fig. 22.

CEPHALIC REGION OF SQUILLA AFFINIS.

Slightly enlarged.

* See remarks on Synonymy under *S. nepa*.

Locality.—There are in the collection one male and three females, brought by J. B. Bernadou, U. S. Navy, then of the U. S. S. *Alert*, from Nagasaki, Japan, and supposed to be from Korea (No. 14116, U.S. N.M.); two males collected by P. L. Jouy in 1885 at Fusan, Korea (No. 12426, U.S.N.M.); a small female from Japan, purchased of H. A. Ward (No. 15628, U.S.N.M.), and a much smaller one from Yokohama, Japan (No. 9347, U.S.N.M.); two specimens from the U. S. S. *Palos* (No. 5145, U.S.N.M.), and a number collected by R. Hitchcock in Japan (No. 13940, U.S.N.M.), and by W. Stimpson at Hongkong (No. 2004, U.S. N.M.).

SQUILLA ALBA, Bigelow.

Plate XXII.

Squilla alba, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 103, 1893.

Diagnosis.—A species possessing very large triangular eyes, the corneal axis being oblique; a pair of large raptorial claws with six teeth on the dactylus; an ovate rostrum with obsolete carinæ; a carapace with five carinæ, the median one not bifurcated in front, with the anterior lateral angles produced into spines, and the posterior lateral angles rounded; no ventral spines, but two lateral lobes on each side of the first exposed thoracic segment, the anterior one being large, strongly curved forward and acute, the posterior one short and rounded; rounded lateral margins on the next two segments, not bilobed; eight carinæ on the abdominal segments; a nearly smooth telson with a low crest ending in a spine and a few curved lines of confluent pits upon its dorsal surface; six marginal spines and between them five to six submedian, twelve intermediate, and one lateral denticle; a large rounded lobe on the inner tooth of the basal prolongation of each uropod and one in the angle between the two teeth.

General description.—This is a well-marked and striking species. The color of the living specimens at once attracts attention. Except for the corneal region of the eyes, which is yellowish, the whole animal is a pure opaque white, marked by only a few symmetrically and definitely placed minute black spots, the positions of which are shown in pl. XXII. The shape of the animal is also peculiar. The carapace and the exposed portion of the thorax are equal in length and together make up about four-ninths of the total length of the body. The segments in front of the carapace are also elongated so that the rostrum does not completely cover the first antennary segment. Moreover, the eyes are unusually large, so that the whole cephalothoracic region has a drawn-out appearance, not well shown in the figure. The rostrum is ovate and nearly smooth, the median and lateral carinæ being only faintly marked.

The general surface of the carapace is smooth and polished; the median carina is not bifurcated in front, but stops short some distance before it reaches the anterior edge of the carapace. The lateral carinæ

run forward very close to the edge and pass into the anterior lateral angles. The first exposed thoracic segment has submedian and lateral carinæ as well as the rest. Its lateral processes recall the condition found in *S. nepa*, Latreille. There are no ventral spines and there is a strong and sharp lateral one curved until it points directly forward and bearing on its posterior side a flattened rounded lobe. The lateral processes of the next two segments are, however, not bilobed, but are broad and rounded and only slightly emarginate on the anterior side. The small lobe on the fourth segment is rounded.

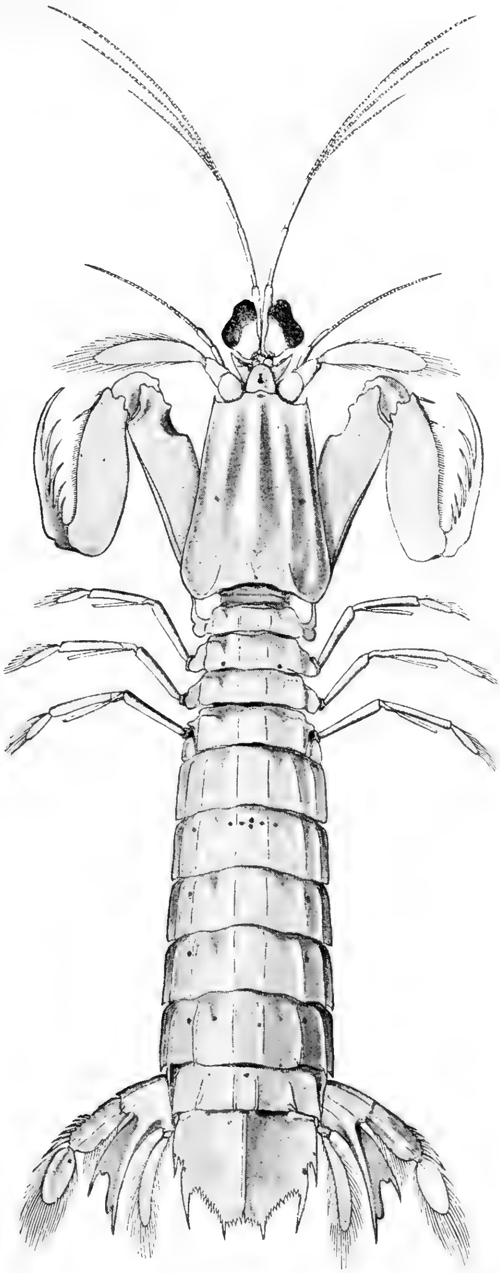
The abdomen is rather compactly put together. Only a small number of carinæ end in spines, namely, the usual six on the sixth segment, all but the submedian on the fifth, and the lateral and marginal ones on the fourth. The spine in front of the articulation of the uropod is very minute or absent. The length of the telson is five sixths of its width at the base. It has an acute median crest ending posteriorly in a stout spine. Of the six marginal spines the intermediate pair is much the longest and stoutest. They all have short low carinæ at their bases. The anterior lateral carinæ form no angles at their posterior ends, but taper off gradually. The lateral denticles are very acute and without elevation at their bases. There are about six oblique, faintly marked rows of confluent pits on the dorsal surface of the telson on each side of the crest, besides the row of pits on each that runs nearly parallel to it. The ventral surface has a corresponding series of obsolete pits and there are faint carinæ also on the bases of the submedian and intermediate spines, an unusual feature, otherwise the ventral surface of the telson is perfectly smooth, there being no keel nor lateral carinæ.

The basal prolongation of the uropod is serrated along its inner margin, and besides the large rounded lobe in the middle of the outer side of the inner spine there is another similar lobe in the angle between the two spines. The first joint of the exopodite is a little longer than the distal one and bears six movable spines.

The corneal portion of the eyes is unusually large in proportion to the size of the body, and is much greater in bulk than the pedicle. The pedicle is small and inversely conical, while the corneal region is voluminous and reniform. The ophthalmic segment bears a short rounded process at the base of each eye. The lateral processes on the next segment are subacute. The first antennæ reach nearly half the length of the body, the first three joints being as long as the carapace. The second antennæ are as long as the carapace, and the antennary scale is about half as long. The raptorial claws, when folded, do not reach to the posterior extremity of the carapace. The carpus has merely a slightly elevated ridge on its anterior margin. The dactylus has a minute projection on its outer margin near the articulation.

The appendages of the walking legs are linear.

Color.—The eyes are yellowish, while the rest of the body is opaque



SQUILLA ALBA.
Nearly three times natural size.

white, with a few symmetrically placed black spots. (See pl. XXII.) The same number of spots is not always present.

Size.—The largest of the two specimens is 4.1 cm. in length.

Locality.—Two females were collected by me in Bimini Harbor, Bahamas, where they were found burrowing in the calcareous sand. (No. 18495, U.S.N.M.).

SQUILLA RUGOSA, Bigelow.

Squilla rugosa, BIGELOW, Johns Hopkins Univ. Circ., 106, p. 102, 1893.

Diagnosis.—A *Squilla* having large triangular eyes with oblique cornea; long raptorial claws, their dactyli armed with six teeth; a subtriangular truncated rostrum, slightly raised at the margin; five longitudinal carinæ upon the carapace, the median and intermediate being interrupted by the cervical suture, and the median one not bifurcate in front; the anterior lateral angles of the carapace produced into acute spines, and the posterior angles rounded; six carinæ on each of the exposed thoracic segments, the lateral process of the first of these segments being lanceolate and acute, with the second and third rounded in front and produced backward into an acute spine; eight carinæ on the first five abdominal segments, all the abdominal carinæ ending in spines except the submedian of the first four segments and the intermediate on the first two; three to four teeth on the posterior margin of the fifth and sixth abdominal segments between the submedian and intermediate spines; ten prominent carinæ on the dorsal surface of the telson on each side of the crest, which ends in a spine, six marginal spines, and on each side five submedian teeth, ten to twelve intermediate, and one lateral one; the basal prolongation of the uropod with eight to twelve long teeth on its inner margin, and a rounded lobe on the outer side of the inner spine.

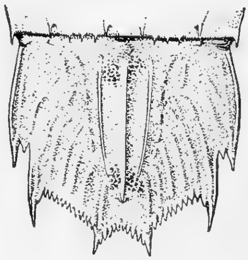


Fig. 23.

TELSON OF SQUILLA RUGOSA.

About twice natural size.

General description.—The first impression one receives on handling a specimen of this species is the marked prominence and sharpness of all its carinæ and spines. The general proportions of the body are very similar to those of *S. quadridens*. The length of the carapace is very nearly equal to one-quarter of the total length of the body and to the greatest width of the abdomen. The greatest width of the carapace is equal to three-fourths its length. The telson is very nearly as long as it is broad at its base.

It is in the uropod, the telson and the adjoining segments that we find the most striking peculiarities of this species. The most prominent of these is the sculpturing on the dorsal surface of the telson (fig. 23). The median longitudinal crest is high and narrow and ends behind in a very sharp spine pointing directly backward. There is a

tubercle beneath the spine. On each side of the crest there is a shorter carina running nearly parallel with it. Outside of this there is another carina taking a similar course but extending to the base of the submedian spine, where it ends abruptly. The proximal two-thirds of this carina is repeatedly interrupted, so that this part of it consists of a series of seven or eight elongated tubercles. Then next outside of this one there is a series of six parallel carinæ running obliquely outward and backward. The fifth one of these extends on to the intermediate spine and tapers gradually to its tip. Then two more carinæ, one beginning at the posterior edge and running along the lateral margin and another parallel one just inside of this. They both taper off on the lateral spine.

The ventral surface of the telson is nearly smooth except for a low keel and two small tubercles, one each side of the anus. The sixth abdominal segment has, besides the usual six dorsal spines, a small marginal spine on each side on the front edge of its articulation with the uropod.

The presence of three or four small teeth on the posterior margin of the fifth and sixth abdominal segments between the submedian and intermediate spines on each side is one of the unusual features of this species. Another one is the presence of from eight to twelve or perhaps more long slender teeth on the inner edge of the basal prolongation of the uropod. The lobe on the inner spine is at about its middle. The proximal joint of the exopodite is but slightly longer than the distal one and it bears from eight to thirteen movable spines; eight is probably the usual number.

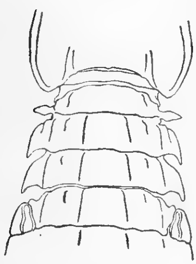


Fig. 24.

EXPOSED THORACIC SEGMENTS OF SQUILLA RUGOSA.

About 1⅜ times natural size.

The rostrum in this species is provided with marginal carinæ, but has no median one. The lateral carinæ of the carapace are continued into the antero-lateral spines. The lateral spine of the fifth thoracic segment (fig. 24) extends outward prominently at right angles to the body. It is very much compressed dorso-ventrally and is lance-shaped. The ventral spines are distinct and triangular in outline. They are compressed obliquely and are straight. The lateral spines on the next two segments point strongly backward.

The eyes are large and broadly triangular, the corneal axis being ten-sevenths the length of the peduncular one and oblique to it. The ophthalmic segment is not at all covered by the rostrum, is acute in front and only very slightly produced into lobes at the bases of the eyes. The lateral lobes of the first antennary segment are acute. The first antennæ are considerably longer than half the length of the body. The second antennæ only reach a little beyond the second joints of the first. The antennary scale is a little more than equal to half the length of the carapace. The raptorial claw is long, and when folded reaches

as far back as the most posterior portion of the carapace. The carpus is without spines. The manus has the usual three movable spines, and the marginal pectinations form a slightly undulating line. The dactylus is rather slender and its outer edge is a simple curve except for a scarcely perceptible tubercle near its base. It is armed with six teeth that gradually increase in length from the base outward. The appendages of the walking legs are linear.

Size.—Length of body, 7.7 cm.

Locality.—The single female specimen in the collection was taken by the *Albatross* in 1885 in the Gulf of Mexico off Charlotte Harbor, N. Lat. 26° 18′ 30″, W. Long. 83° 8′ 45″ at a depth of 27 fathoms (No. 9835, U.S.N.M.).

THE LARVÆ.

The ontogeny of the Stomatopoda includes a remarkable metamorphosis, and the animals while in the larval stage bear so little resemblance to their adult form that it was but natural that the earlier zoologists should suppose them to be adults of another family and should give to them generic and specific names. We are indebted to the researches of Claus (1871), Faxon (1882), and Brooks (1879, 1886, and 1892) for our knowledge of the true relationship of these forms. While they are now only entitled to bear the names of adult species of which they are the immature representatives, it is still convenient in speaking of them to use the old generic names, and Brooks (1886) extended this terminology at the same time that he pointed out distinguishing characters of the representative larval forms of most of the genera, so that now for each one of the principal adult genera we have a corresponding larval type. The ontogeny of *Protosquilla*, *Pterygosquilla*, and *Leptosquilla* is unknown. The chief characteristics of the larval forms of the other genera are displayed in the following:

ANALYTICAL KEY TO THE TYPES OF STOMATOPOD LARVÆ.

I. Eyes sessile; appendages I–X developed and XIV–XVII also budded in older stages..... ERICHTHOIDINA, Claus. (An early stage; adult form unknown).

II. Eyes stalked; appendages I–VII and XIV–XVII, present in earliest stages.

* *Erichthus* Form: Telson usually quadrate or hexagonal in general outline, with never more than 4 intermediate denticles.

† Body elongated; carapace narrow without prominent ventro-lateral angles and with posterior lateral angles near the dorsal surface.

Telson slightly wider than long, and notched on the median line; posterior lateral spines of carapace long; never any trace of lateral teeth upon the raptorial dactylus.

GONERICHTHUS, Brooks. (Larva of GONODACTYLUS).

Like the above, but the dactylus of the raptorial limb showing traces of lateral teeth in the oldest stages.

ODONTERICHTHUS, new type. (? Larva of ODONTODACTYLUS).

Hind body very long; telson longer than wide, sometimes ovate in general outline; carapace narrow and short with short rostrum and short postero-lateral spines:

PSEUDERICHTHUS, Brooks. (Larva of PSEUDOSQUILLA).

† † Body short; carapace large and wide, infolded on the ventral side, with prominent ventral angles, and posterior lateral angles widely separated from the median line.

Hind body wide and flat; telson wider than long.

LYSIOERICHTHUS, Brooks. (Larva of LYSIOSQUILLA).

* * *Alima* Form: Telson usually octagonal in general outline with numerous intermediate denticles.

† Basal spines of each uropod small and equal.

Body short and broad, nearly covered by the carapace, which is folded downward and inward.

ERICHTHALIMA, Brooks. (? Larva of CORONIDA).

† † The inner one of the basal spines on each uropod the longer.

Hind body short and broad; carapace broad, covering all but the last thoracic segment, but not folded in at the sides.

ALIMERICHTHUS, Claus. (? Larva of SQUILLA [CHLORIDELLA]).

Body greatly elongated; carapace flattened, elongated, and narrow (about $\frac{1}{4}$ as wide as long); usually several thoracic segments exposed .... ALIMA, Leach. (Larva of SQUILLA).

General remarks on the collection.—The collection of larvæ is of considerable size, but it is not worth while for us to linger over it, for it contains but few forms of special interest, no consecutive series, and no stages that can be assigned with certainty to any adult species. The most striking features are the quantity of large Lysioerichthi from the Atlantic and the number of very large Alimæ from the Bay of Panama. The former resemble the specimen figured by Brooks (1886) in pl. x, fig. 7, and which he regards as the young of *Lysiosquilla maculata*. The latter are of two species, one with a very wide carapace and the other with a narrow one. It seems probable that these will be found to be the larvæ of the two large species of *Squilla* that are common at Panama—*S. panamensis* and *S. biformis*.

The larvæ of stomatopods are sometimes to be found in immense schools. While with the Johns Hopkins University Marine Laboratory at Bimini in the summer of 1892 I found a few stomatopod larvæ of various kinds and stages almost every time that the towing net was used, but after dark on the evenings of July 19, 20, and 21 the towing nets were crowded with an immense number of very small Gonerichthi, apparently identical with the form represented by Claus (1871) in his fig. 22 B.

THE ODONTERICHTHUS LARVA.

Two specimens among the larvæ from the Atlantic are of especial interest. They are probably in the last larval stage and exhibit most of the characters of Gonerichthi except that lateral teeth are to be seen beneath the larval skin on the dactylus of the raptorial limb. It is evident that they can not be larvæ of *Gonodactylus*, but, if Brooks is right in regard to the relations of the larval forms, the specimens before us must belong to a genus very closely related to *Gonodactylus*. The nearest one is *Odontodactylus*, and it seems probable that these

larvæ belong to two unknown species of that genus. They therefore represent a new larval type for which I propose the name *Odonterichthus*.

One of them (No. 9958, U.S.N.M.) was taken by the *Albatross* October 3, 1883, at station 2101, off Nantucket. It is represented in fig. 25. A comparison of this figure with Brooks' fig. 5, pl. XII, which represents a *Gonerichthus* from St. Vincent, Cape Verde, will show a striking similarity. They both exhibit the form of body, the shape of the carapace, and telson, that Brooks has shown to be characteristic of the *Gonodactylus* larvæ. An examination of fig. 25 will convey a better idea of this interesting form than pages of description. It will be seen that the specimen before us differs from Brooks' in having a somewhat shorter rostrum with five or six small spines on the ventral

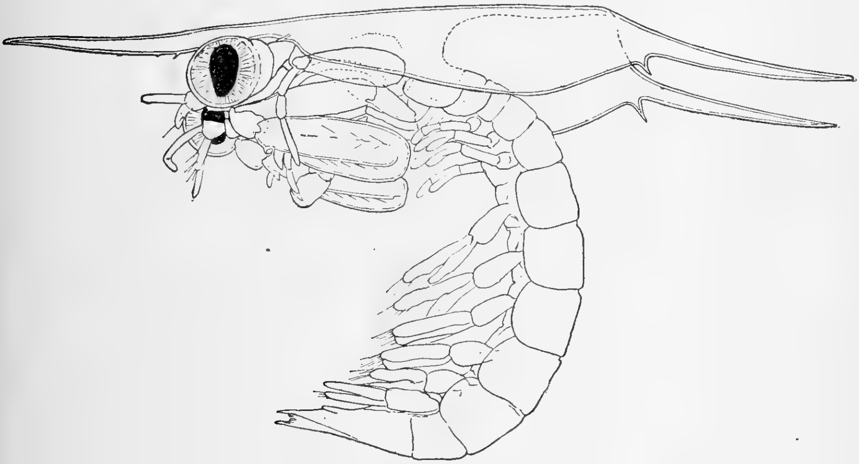


Fig. 25.

ODONTERICHTHUS LARVA.

Two teeth on the rostrum are hidden by the eye. Drawn with a camera lucida × 14.

side, and in having a minute additional secondary spine on the ventral edge of the carapace. The dactylus of the raptorial limb is much more developed and shows five lateral teeth beneath the larval skin. The similarities are so much greater than the differences that the latter may be due merely to a difference in age, the one being an older stage of the other. These forms would appear to belong to a species in which the larvæ can be distinguished from Gonerichthi only after the teeth begin to form on the raptorial dactylus.

The other species, however (fig. 26), is not so similar to the Gonerichthus type, but approaches the Pseuderichthus form, and this is just what we should expect if my view be accepted that this is a larva of *Odontodactylus*, because this genus is distinctly intermediate in some

of its characters between *Gonodactylus* and *Pseudosquilla.* Compare *Odontodactylus havanensis* (pl. XX) with *Gonodactylus chiragra* on the one hand and with *Pseudosquilla ciliata* on the other, and then compare this larva (fig. 26) with a typical *Gonerichthus* and a typical *Pseuderichthus*, as, for instance, the forms figured by Brooks* on pl. XII, fig. 6, and on pl. XV, fig. 11, respectively. It will be seen that this larva

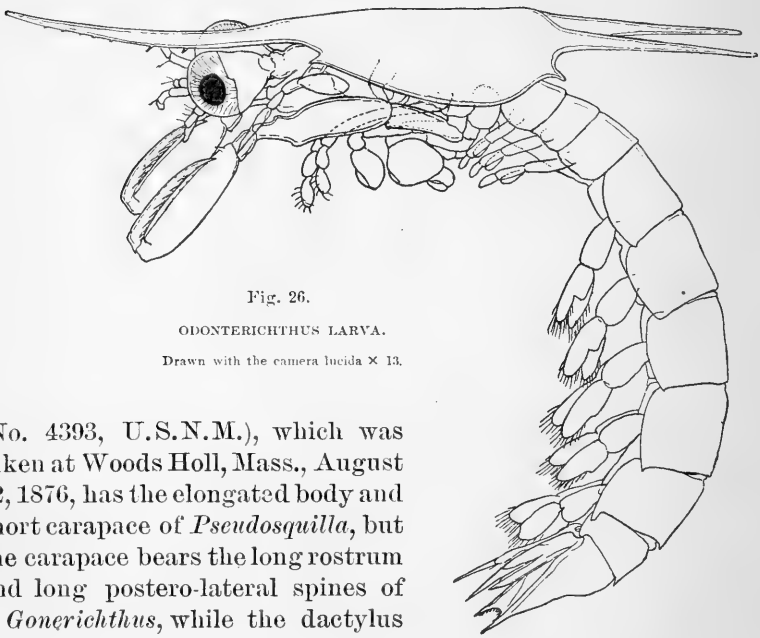


Fig. 26.

ODONTERICHTHUS LARVA.

Drawn with the camera lucida × 13.

(No. 4393, U.S.N.M.), which was taken at Woods Holl, Mass., August 22, 1876, has the elongated body and short carapace of *Pseudosquilla*, but the carapace bears the long rostrum and long postero-lateral spines of a *Gonerichthus*, while the dactylus of the raptorial limb shows traces of seven or eight lateral teeth. It is thus excluded from either of the genera with which we have been comparing it. *Odontodactylus havanensis*, however, has six lateral teeth upon the dactylus and *O. hansenii*, recently described by Pocock (1893) has nine distinct teeth, so that our larva may well belong to this genus. It probably belongs to some West Indian species, was swept north by the Gulf Stream and then driven into Woods Holl by a southerly wind, for such has been the fate of many tropical creatures.

Brooks also found in the *Challenger* collections "larvæ which closely resemble *Pseuderichthus*, although they may be *Gonodactylus* larvæ;" perhaps they are younger stages of *Odonterichthus*.

THE METAMORPHOSIS OF SQUILLA QUADRIDENS.

At Bimini on the 7th of July, 1892, several Alimæ were taken in the tow net. The two largest ones appeared to be alike on a superficial examination and were distinguished from the rest by the great elongation of the body in proportion to its width. One of these was preserved

* Voyage of the *Challenger*, XVI, part 45, 1886.

in alcohol and is represented in fig. 27. The other was left in the aquarium, and on July 9 it molted in the form seen in fig. 28. Unfortunately the two larvæ were not compared carefully before the molt, but I have no doubt that they were identical in form, for there was no difference in general appearance, and a careful comparison of the specimen represented in fig. 27 with the older one in fig. 28 shows so many features in common that one can hardly doubt that the one form is derived from the other, and this opinion is confirmed by the entire absence of any characters inconsistent with such a view. Of course, these two forms are separated by the critical change from the larval to the adult form, and there is more difference between them than between any other two stages.

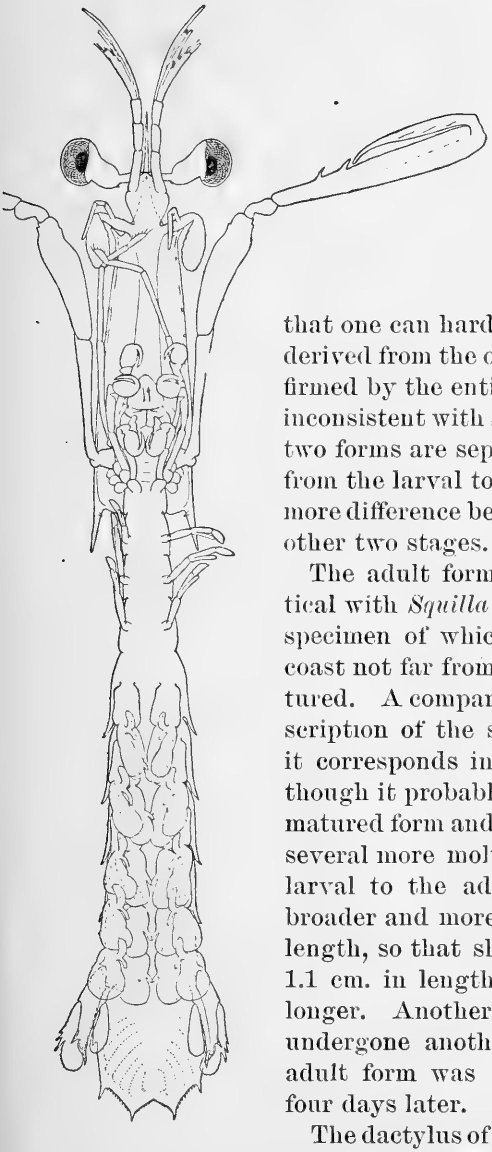


Fig. 27.

LAST ALIMA STAGE OF SQUILLA QUADRIDENS.

Drawn with a camera lucida × 8.

The adult form (fig. 28) appears to be identical with *Squilla quadridens*, Bigelow, the type specimen of which was found on the Florida coast not far from where these larvæ were captured. A comparison of the figure with the description of the species (p. 511) will show that it corresponds in all the chief characters, although it probably would not assume its fully matured form and detail of structure until after several more molts. In the passage from the larval to the adult form the body becomes broader and more compact at the expense of its length, so that shortly after the molt it is but 1.1 cm. in length, while before it was 0.5 cm. longer. Another specimen which may have undergone another molt since assuming the adult form was captured by the towing net four days later.

The dactylus of the raptorial limb in the larva (fig. 27) is unarmed, but one can see three lateral teeth in addition to the terminal one lying beneath the larval skin. In this way it corresponds to the adult form, and at the same time recalls Brooks's description (1886, pp. 90–93), of *Squilla* (*Alima*) *bidens*, Claus, but a comparison of this description and the

accompanying figures with our form shows so many differences that the two must be distinct.

Our larva, *Squilla* (*Alima*) *quadridens*, is in the first place much smaller than *Alima bidens* at the stage with three lateral teeth on the dactylus, the later being an inch in length while the length of the former is but 1.6 cm.

Then in our form the carapace is relatively shorter and narrower, making with the rostrum less than two-fifths of the total length of the body measured along the median line. The rostrum does not extend beyond the shafts of the first antennæ and does not equal half the length of the rest of the carapace. The anterior lateral angles are not so prolonged, and the posterior lateral spines reach only so far as the boundary between the second and third of the four posterior thoracic segments, which are left exposed by a deep incision in the posterior margin of the carapace. There is a single secondary spine at the base of each posterior lateral process and three or four minute ones on the side of the carapace in front of the mouth. The hind body is more elongated than in *Alima bidens* and comprises more than three-fifths of the total length from the tip of the rostrum, but, as in that species, all of the posterior lateral angles of the first five abdominal somites end in acute spines, and there are two submedian spines on the sixth. The shape of the telson is very similar to that of the other species, but it has a different number of secondary denticles, there being on each side fifteen submedian, eight to nine intermediate, and no lateral ones, while in *A. bidens* they are 20±, 12–13, 0. The basal prolongation of the uropod shows beneath the larval skin the characteristic form of the adult, including traces of the acute teeth on the inner side. The raptorial claw is more slender than in *A. bidens*, and the manus bears two equally

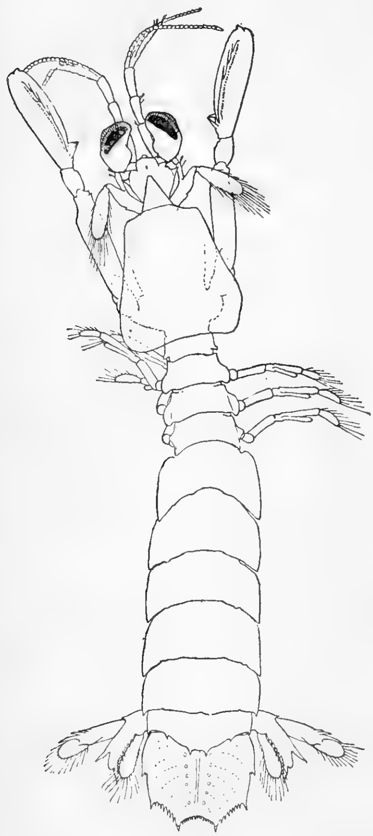


Fig. 28.

FIRST STAGE OF ADULT FORM OF SQUILLA QUADRIDENS.

Drawn with the camera lucida × 8.

large curved teeth on its proximal portion instead of 1 large one, and has numerous minute teeth on its distal portion.

A number of Alimæ were found at the same time in earlier stages. They are all of one species which is very similar to or identical with *Alima gracilis*, Milne-Edwards, and they may be the earlier stages of the form that I have just described, but no decision can be reached on this point, as the necessary intermediate stages are wanting.

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THE PTERYLOGRAPHY OF CERTAIN AMERICAN GOAT-SUCKERS AND OWLS.

By HUBERT LYMAN CLARK.

A RECENT examination of a number of Caprimulgi and Striges for the purpose of studying their pterylographical characteristics has proved of such interest that the results seem worthy of publication, although the work is necessarily only preliminary. In the carrying on of these studies I have been placed under great obligation to Dr. R. W. Shufeldt and Mr. F. A. Lucas, of Washington, for many helpful suggestions, and to the National Museum for much of the material. For the rest of the material I am indebted to Mr. F. A. Ward, of Rochester, and especially to Mr. Frank B. Armstrong, of Brownsville, Tex., who has given me invaluable assistance. I am also under great obligations to Dr. W. J. Holland, of Pittsburg, for the use of his valuable scientific library, without which I should have been placed at great disadvantage.

All of the specimens examined have been birds in the flesh, either fresh or alcoholic, as the use of skins for the study of pterylography seems to be of questionable value. Owing to the fact that Striges have eleven primaries while Caprimulgi have only ten, I have adopted the somewhat radical change advocated by Wray* of numbering the primaries from the wrist outward instead of from the tip of the wing inward, as is usual. Although I do not consider the plan wholly free from objections, it has been necessary to do this to avoid inextricable confusion in comparing the primary formulæ in the two groups, for the real first primary of the owls is wanting in the Caprimulgine wing. For the same reason the central pair of tail feathers is designated as number one and the outer pair five or six, as the case may be.

As the four genera of North American Caprimulgi have all been examined, I give first as complete a review of the pterylosis of this group as the material at hand will warrant, with particular reference to each genus. After this is given an account of such owls as have been obtainable, and this is followed by a comparison of the pterylography of the two groups and the conclusions to which I have been led. The work is, as already stated, only preliminary, and, of course, can only be completed by a study of all the important species of both

* Proc. Zool. Soc. London, 1887, p. 313.

groups, but it is hoped that the present article may not only serve as an introduction to such a work, but may also arouse more interest in the study of comparative pterylography.

CAPRIMULGI.

In Nitzsch's "System der Pterylographie" there is given a fairly complete account of the pterylosis of *Caprimulgus europæus* and further remarks on *C. longipennis*, *forcipatus*, and *spalurus*, *Ægotheles novæ hollandiæ*, *Podargus gigas*, and *Nyctornis æthereus*, but apparently the celebrated German had not examined our North American species. Dr. Shufeldt has carefully described the pteryloses of *Antrostomus* and *Chordeiles* in his memoir on the Macrochires,* and the former is figured. So far as I know these are the only important papers which have yet appeared bearing directly on the pterylography of the group, unless we include *Steatornis*, which has been examined and the pterylosis figured by Garrod,† although it is not improbable that others may have escaped my search.

The Caprimulgi are remarkable for the variations shown in the pteryloses of the different genera, but the plan is similar in all the North American species and may be briefly summed up as follows: The whole head is fully covered with feathers, which are, however, arranged in more or less complete and often parallel longitudinal rows, forming on the forehead and crown definite patterns, each genus having its own peculiar arrangement. From the head there extends backward dorsally the upper cervical tract which, dividing between the shoulders into two strong forks, extends to the end of the shoulder blades. The dorsal tract, which begins immediately behind this fork, shows great variation in its distinctness and extent, but is usually more or less forked at first and then, uniting into a single tract, runs backward to the root of the tail. Anteriorly it may unite its two branches with those of the cervical tract, thus inclosing a diamond-shaped spinal space, as best shown in *Phalænoptilus*, or it may spread out more decidedly toward the sides and even send forward a few feathers almost to the humeral tracts, as is well shown in *Chordeiles virginianus*. The humeral tracts are strongly defined, and the upper surface of the wing is very completely feathered, except for an evident apterium at the outer end of the humerus. The parapterum is not always very evident, but usually connects the humeral tract with the feathers of the forearm, of which there are seven or eight more or less complete rows, the lower three or four being the secondary coverts, while there are also two very strong rows of primary coverts. Directly at the knee-joint is a prominent femoral tract, which, after crossing the tibia diagonally, extends part way along the posterior edge of the femur, although it never reaches as far as the dorsal tract. The pterylosis beneath is more uniform. The

* Jour. Linnean Soc., XX, pp. 299–394.

† Proc. Zool. Soc., 1873, p. 526.

lower cervical tract forks at about the middle of the neck and each branch extends down over the side of the breast, where it is very broad and strong, and then (as it enters on the surface of the abdomen, or a little before) suddenly contracts to a strip only two rows broad, which curves inward and ends a little in front of the anus. The hypopterum is generally very evident and connects the sternal tract with the incomplete fourth row of under wing coverts. The lower surface of the wing is very slightly feathered, but there are two complete rows of primary and three of secondary coverts and an incomplete fourth row of the latter. The four genera agree also in the following details:

Aftershafts present but weak. True down wanting. Oil gland not tufted. Primaries, 10. Rectrices, 10. Alula feathers, 3. Secondaries, 12 or 13, but the wing is aquincubital.

The larger wing and tail feathers are all peculiar in the length of the quill (*calamus*) and the corresponding shortening of the shaft (*rhacis*) which ends with the vexillæ. The four genera fall naturally into two groups, as follows:

I. Secondaries, 12; tail not forked, the central pair of rectrices longest; rictal bristles very prominent; infra-mandibular region sparsely feathered; no inner branch or tooth on the lower cervical tract.
  A. Only 8 complete longitudinal rows of feathers on the crown. Tarsus not feathered at all .... PHALÆNOPTILUS.
  B. Eight complete rows, but tarsus feathered halfway down in front. ANTROSTOMUS.
  C. Ten complete rows and tarsus not feathered .... NYCTIDROMUS.
II. Secondaries, 13; tail forked, central pair of rectrices shortest; rictal bristles not evident; inframandibular region well feathered; lower cervical tract with a prominent inner tooth.
  A. Ten complete rows on crown. Tarsus feathered in front ...... CHORDEILES.

Genus PHALÆNOPTILUS.

Of this genus I have only had the opportunity to examine one specimen, but as that was in good condition, it probably illustrates correctly the pterylosis of the genus. As the primaries had been cut off, the formula for their comparative lengths can not be given, but there were 12 secondaries. On each side of the head, along the edge of the rictus, there is a single row of long, stout, bristle-like feathers. Above this is a second row of smaller contour feathers and above this a third incomplete row of the same. From the base of the culmen (fig. 1) there run backward on each side two rows of contour feathers, so near together as to almost make a single row. For a short distance these double rows are about parallel, and then curving inward they unite for a short distance into a band three rows broad. On the crown they separate once more into four distinct rows, which, although somewhat curved, are almost parallel* for some distance, but unite again at the commencement of the cervical tract. Another row begins on each

* Used in the sense of being equidistant at all points.

side just behind the nostrils and runs backward into the cervical tract almost parallel to those first described. The fourth complete row on each side commences under the eye, near the angle of the mouth, and after running forward a little way curves up and back and runs parallel to the others into the cervical tract. There is another incomplete row on each side, which begins about the middle of the upper eyelid and runs down the back of the head behind the ear, but does not seem to join in the cervical tract. The rows are closer together than in any of the other genera and curve as shown in fig. 1. The upper cervical tract is quite broad and is clearly and widely forked at the end. The dorsal

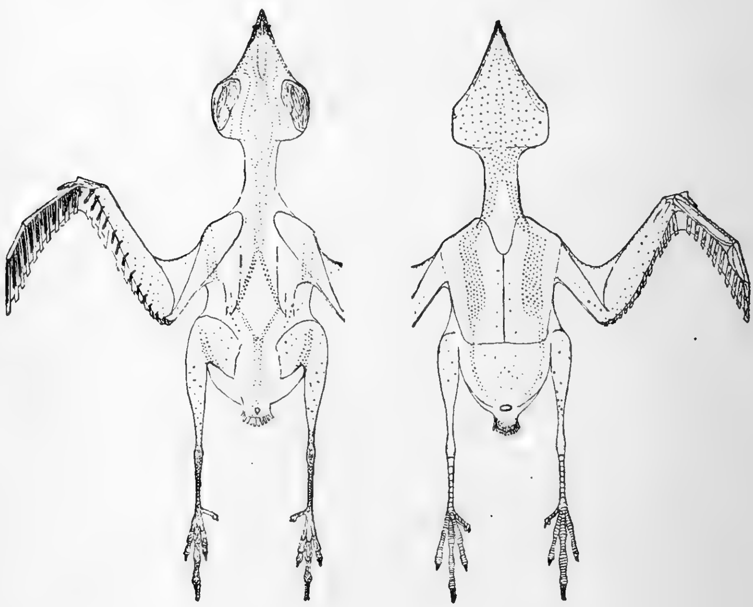


Fig. 1. Fig. 2.

PTERYLOSIS OF PHALÆNOPTILUS NUTTALLI.

tract extends forward from the oil gland, in a rather narrow band which is forked in front and unites plainly with the cervical tract, thus inclosing a diamond-shaped spinal space. There are on each side of this fork a few scattered contour feathers, but they are not very evident. The femoral tract is clearly defined, but is not peculiar in any way, though on the femur between it and the dorsal tract there are many scattered contour feathers. There are also a few such feathers on the tibia, but there are none on the tarsus. The humeral tracts are strong and extending clear across the shoulders unite with the ventral tracts. The feathers on the chin and throat (fig. 2) are widely separated and are arranged in more or less longitudinal rows which converge in front to

unite at the base of the gonys. The lower cervical tract is broad and divides near the middle of the neck. The ventral tract contracts on the breast some distance before reaching the posterior edge of the sternum and ends a little in front of the anus. There are scattered contour feathers on the belly and on the sides of the breast anterior to the hypopterum.

Specimen examined.

No.	Name.	Collection.
1	Phalænoptilus nuttalli	U. S. National Museum.

Genus ANTROSTOMUS.

In general, this genus seems to agree very well with *Phalænoptilus*. The ten primaries give the following formula in comparative lengths: 8=9, 7=10, 6, 5, 4, 3, 2, 1, and there are 12 secondaries. The pattern

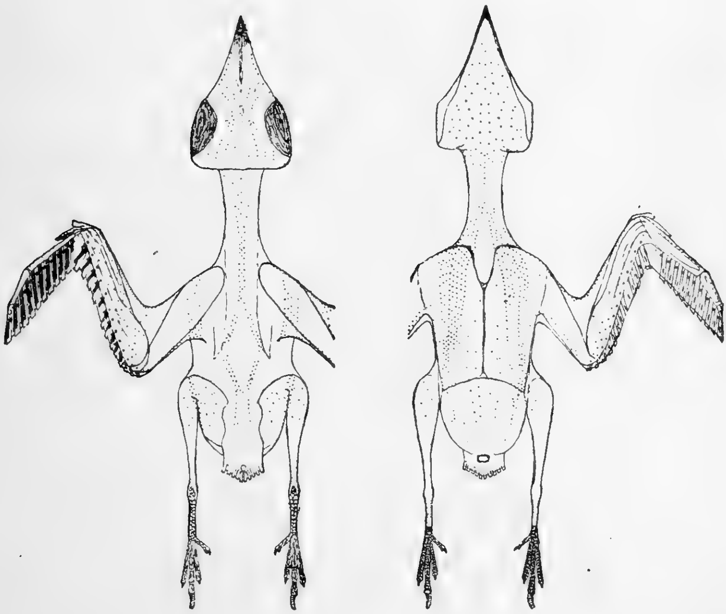


Fig. 3. Fig. 4.

PTERYLOSIS OF ANTROSTOMUS VOCIFERUS.

of the head-feathering (fig. 3) differs from the preceding genus in the absence of the third row along the rictus; in the greater curvature and wider separation of the rows and in a few other minor details easily seen on an examination of the plates. The upper cervical tract is broad at the start but becomes rapidly very narrow, while the rest of the upper

surface agrees with *Phalænoptilus*, although the dorsal tract is much broader, and there appear to be no scattered contour feathers on the back. Ventrally *Antrostomus* differs from the "Poor-wills" in a much greater sparseness of feathers on the chin (fig. 4) and in the continued breadth of the sternal tracts, which become narrower only as they enter on the surface of the abdomen. The feathering of the tibia does not end at the joint, but extends down on the tarsus in front, more than half way to the toes.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Antrostomus vociferus	U. S. National Museum	Alcoholic.
2	do	Brownsville, Tex	Fresh.

It will at once be seen from the above description and figures that my observations on the pterylosis of this genus differ radically from those of Dr. Shufeldt.* In regard to this difference, Dr. Shufeldt assures me that he has compared his figure, since its publication, with other specimens and has found no changes necessary. He has, however, very kindly permitted me to examine his original drawings, and it is only fair to say that they do not differ so much from mine as do the figures in the plate. The latter seems to have been very carelessly executed, and so it is desirable to have a more accurate figure, which I hope is to be found above.

Genus NYCTIDROMUS.

In this genus the wing is very much like *Antrostomus*, as there are twelve secondaries, and the ten primaries give the following formula: 8, 9, 7, 10, 6, 5, 4, 3, 2, 1.

On the head (fig. 5) we find an arrangement of the rows quite different from the other three genera. There is the usual double row running from the foot of the culmen over the middle of the head, back to the cervical tract. Beside this and parallel to it are two single rows some distance from it and from each other. There is then a fifth complete row, running from the angle of the mouth beneath the eye, forward, then up and back over the upper eyelid, and finally into the cervical tract with the other four. From the inner side of this row a branch runs forward for some distance along the superior edge of the eye cavity. The row of rictal bristles is prominent, and there are a number of contour feathers, filling the space between it and the fourth longitudinal row. The upper cervical tract is very narrow, while the dorsal tract is rather broad. The spinal space is not very clearly defined, and there are several rows of strong contour feathers (with weaker ones scattered about) running at almost right angles to the dorsal tract, extending out from its anterior end. The femoral tracts are unusually well developed, and the tibiæ are feathered very

* Journal of the Linnean Society, xx, p. 299.

sparsely, but the tarsus is wholly bare. The humeral tract shows the remarkable peculiarity of not reaching entirely across the shoulder, but becomes almost obliterated at its anterior end. This was clearly shown in all the specimens examined. In the infra mandibular region the feathering is even more scattered than in *Antrostomus*, so as to

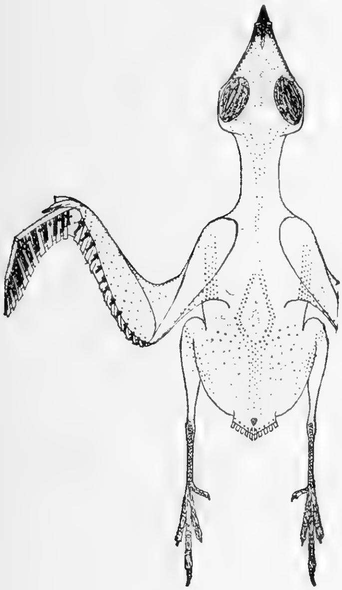


Fig. 5.

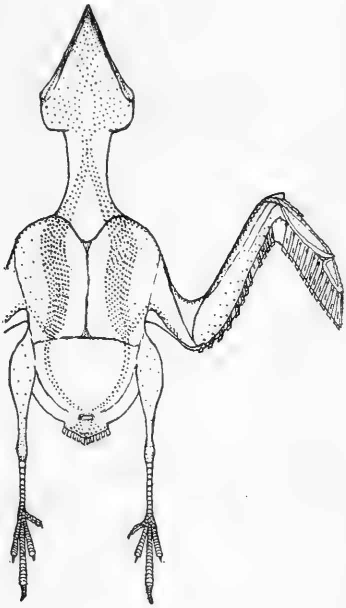


Fig. 6.

PTERYLOSIS OF NYCTIDROMUS ALBICOLLIS MERRILLI.

leave two very distinct and complete apteria (one on either side) and a less evident one in the center. The lower cervical tract (fig. 6) is very narrow and is deeply forked. The parapterum is not very strong, and in one specimen the hypopterum nearly failed altogether. In all other respects, however, it seems to agree with *Phalænoptilus*.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Nyctidromus albicollis	U. S. Nat. Mus	Alcoholic.
2	Nyctidromus albicollis merrilli	Brownsville, Tex	Fresh.
3	do	do	Do.
4	do	do	Do.
5	do	do	Do.
6	do	do	Do.
7	do	do	Do.

Genus CHORDEILES.

In all of the specimens examined the primaries had been cut so that their formula can not be given, but there were 13 secondaries. On the head we see that the rictal bristles are so insignificant as to leave in

the plucked bird very little trace of their presence. There is on each side of the crown the usual double row of feathers running backward from culmen to cervical tract, and beside this, but at some distance from it, two widely separated parallel longitudinal rows. A fifth row runs across the extreme upper part of the eyelid with an outer branch down to the eyelid proper. The upper cervical tract is very broad in *C. virginianus* (fig. 7), but in *C. texensis* it is as narrow as in *Antrostomus*. In *C. virginianus* the fork of the cervical tract is very strong, but that of the dorsal tract is very indistinct, while from each side of the latter there

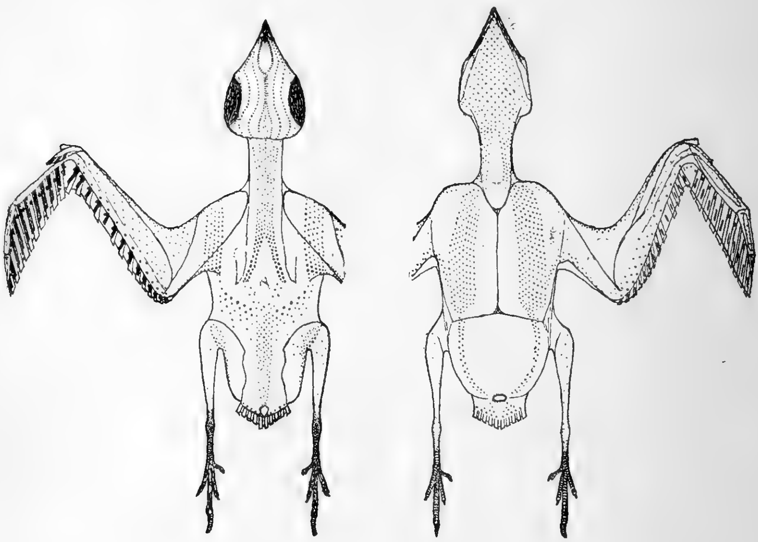


Fig. 7. Fig. 8.

PTERYLOSIS OF CHORDEILES VIRGINIANUS.

extends a broad tract out and up over the back so as to connect very slightly with the broad humerals. In *C. texensis* the dorsal tract is much like *Antrostomus*, and there are no traces of the peculiar tracts, just described, on the sides of the back. In both species of *Chordeiles*, however, the femoral tracts are normal and the feet are feathered half-way down on the tarsus in front. On the lower surface (fig. 8) the two species agree with *Phalænoptilus*, except that the infra-mandibular region is very well feathered and the lower cervical tract, dividing very far up on the throat, bears on its inner edge, close by the furcula, a very noticeable branch or tooth, while the sternal tracts are remarkably broad and strong.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Chordeiles virginianus	U. S. Nat. Mus	Alcoholic.
2	Chordeiles virginianus henryi	do	Do.
3	Chordeiles texensis	do	Do.

In regard to the differences in the dorsal tract as above given between *C. virginianus* and *C. texensis*, it is probable that an examination of fresh material, which it was impossible for me to obtain, will show that they are not so great as I have indicated. Indeed, it is likely that good specimens of *C. texensis* will show dorsal tracts similar to *C. virginianus*, as Dr. Shufeldt found them so in the specimens which he examined.*

STRIGES.

In his System des Pterylographie, Nitzsch has given an account of the pterylography of some 21 species of owls, of which at least five are American, namely: *Strix virginiana* (*Bubo virginianus*), *S. brachyotus* (*Asio accipitrinus*), *S. asio* (*Megascops asio*), *S. nyctea* (*Nyctea nyctea*), and *S. cunicularia* (*Speotyto cunicularia*). Besides these, *S. lapponica* is closely allied to our *Scotiaptex cinerea* and *Hybris flammea* is represented in our *Strix pratincola*. Aside from Nitzsch's work the only contribution to the pterylography of the owls which I have found is contained in some "Notes on the Anatomy of Speotyto cunicularia hypogæa" by Dr. Shufeldt,† in which is given a very complete and accurate account of the pterylosis of the burrowing owl; important differences between that form and the other owls being pointed out. As a rule, however, it may be safely said that the owls show a striking uniformity in the arrangement of the feathers, of which the general plan is as follows: The head is more or less fully feathered above, and especially densely in front. The upper cervical tract usually commences broad, but rapidly becomes narrow, and forks between the shoulders more or less deeply. The dorsal tract is very incomplete anteriorly and is only indistinctly connected with the cervical forks, but posteriorly it becomes a strong single band, which forks behind so as to more or less surround the oil gland. The humeral tracts are strong and usually broad and the parapterum is very evident. There are two complete rows of primary coverts, and on the forearm there are seven or eight rows of feathers, of which the lower three or four are true secondary coverts. The femoral tract is very strong and evident, running obliquely across the upper end of the tibia from the knee, along on the posterior edge of the femur. The tibia and tarsus are usually very completely covered with feathers, and often the toes also. At the base of the gonys the infra-mandibular region is very thickly feathered, but this dense patch divides abruptly and either passes up on each side and runs along the ear-conch, as in those owls in which this conch is fully developed, or, as in other species, disappears on the rami of the lower jaw. The rest of the chin and throat are very sparsely feathered in most owls, but in others it is fully covered. The lower cervical tract is narrow and is divided on the neck so as to pass down on either side to form the strong sternals. It is also connected with the humerals, and especially with the

* Jour. Linn. Soc., xx, p. 341.
† Jour. of Morph., June, 1889.

triple row of small feathers on the lower edge of the patagium, while all of the upper outer corner of the breast is usually more or less feathered. From the lower end of the sternal tract there runs a strong hook over to the hypopterum, which is itself very evident. There are two rows of primary and three or four of secondary under coverts. The ventral tracts commence on the breast, usually near the furcula, and seem to be fused with the sternals at first, but soon separate from them and run down on either side almost to the anus, becoming very narrow on the belly. *Strix* shows a very peculiar modification of this typical form, in the fusion again of the sternal and ventral tracts at the posterior end of the former. The post-anal tract, comprising the under-tail coverts, is strong and very conspicuous in the larger species. All of the specimens of Striges examined agreed in the following details:

Aftershafts wanting. True down wanting. Oil gland not tufted. Primaries 11, the eleventh very small. Rectrices 12 (except *Micropallas*). Alula feathers 4. Wing aquincubital.

As only nine species, representing eight genera, have been available for study they can not be very satisfactorily arranged in groups pterylographically, but when all the genera are examined such an arrangement may be possible. For the sake of convenience I have, however, divided the eight genera as follows:

I. Head uniformly and thickly feathered above and sometimes below, although the lateral neck spaces reach nearly to the ears and the infra-mandibular region is sometimes sparsely feathered, often showing apteria along the rami of the lower jaw.
  A. Rectrices 10 .... MICROPALLAS.
  B. Rectrices 12.
    a. Upper cervical tract well forked; ninth, eighth, and seventh primaries longest .... SPEOTYTO.
    b. Upper cervical tract slightly forked; seventh, sixth, and eighth primaries longest .... GLAUCIDIUM.

II. Head not uniformly feathered, but usually showing longitudinal rows on the crown, and the infra-mandibular region is very sparsely feathered.
  A. Sternal tract free from ventral at posterior end; outer pair of rectrices shortest.
    a. Linear arrangement of feathers near the center of the crown between the eyes, but on account of their nearness to each other not showing any very definite pattern; lower cervical tract clearly defined on the chin .... SYRNIUM.
    b. Linear arrangement of feathers on the crown forming a definite pattern between the eyes or else not evident at all; lower cervical tract indistinct on the chin; ninth, eighth, and seventh primaries longest. ASIO.
    c. Linear arrangement of feathers on the sides of the crown, back of the eyes.
      1. Tarsus fully feathered; seventh, sixth, and eighth primaries longest. MEGASCOPS.
      2. Tarsus only feathered in front halfway to the toes .... GYMNOGLAUX
  B. Sternal tract fused with ventral behind as well as in front; middle pair of rectrices shortest.
    a. Ninth, eighth, and tenth primaries longest .... STRIX.

NOTE.—The above arrangement is not intended to show any affinities between these genera, but simply to set out more prominently some of the differences.

Genus MICROPALLAS.

Unfortunately, I have only had the opportunity to examine one specimen of this very interesting genus of little owls, but Mr. Lucas and Mr. Ridgway have very kindly examined the skins of both *M. whitneyi* and *M. graysoni* in the National Museum, and have thereby confirmed its chief peculiarity, namely, the presence of only ten rectrices. Indeed, the specimen which I examined had only nine, but there is a possibility that one had been lost accidentally. The primaries had been cut, and so their formula can not be given, but there were only 13 secondaries. In the general pterylosis this genus differs from *Asio accipitrinus* (figs. 9 and 10) in the uniform feathering of the head above and below, except the naked space over the eye; in the narrowness and weakness of all the tracts, but especially the femoral; and in the somewhat less complete feathering of the toes, where the feathers are very hair like. The dorsal tract and the posterior end of the cervical were not easy to make out, but seemed to be like *Asio*. In fresh specimens, however, I should expect to find the cervical tract scarcely forked and the dorsal extending forward so as to almost meet it, as in *Glaucidium*.

Specimen examined.

No.	Name.	Collection.	Condition.
1	Micropallas whitneyi	U. S. Nat. Mus	Alcoholic.

Genus SPEOTYTO.

Although this genus shows some modification of the typical Strigine pterylosis, it did not seem necessary to publish a figure, as one has already appeared with a full account of these differences in the Journal of Morphology for June, 1889, by Dr. Shufeldt. All the specimens which I have examined agree with the description there given, although really the width of the tracts is not so especially noteworthy when compared with our other owls as in comparison with the figures of Nitzsch. Indeed, I have not noticed in any of the owls which I have examined the extreme narrowness of the tracts to which Nitzsch called attention, although they may be narrower than those of the hawks and some other birds. The chief peculiarity of *Speotyto* lies in the uniform feathering of the whole head, more complete than in any other owl I have seen. This was especially clear in the young bird from the National Museum, where the sides of the head were more fully clothed than in the adults. The lateral neck spaces are broad and do not reach quite to the ear, as in other owls, but permit, instead, a slight union of the upper and lower cervical tracts on the sides of the head. In all other respects *Speotyto* agrees with *Asio*, except that the tarsus is only feathered to the base of the toes, and that only in front. The eleven primaries rank as follows in length: 9 = 8, 7, 6 = 10, 5, 4, 3, 2, 1, 11.

There are fifteen secondaries and twelve retrices, but of the latter one bird from the National Museum (No. 85253) possessed thirteen.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Speotyto cunicularia hypogæa	U. S. Nat. Mus	Alcoholic.
2	......do	......do	do.
3	Speotyto cunicularia hypogæa (young)	......do	do.
4	Speotyto cunicularia hypogæa	Brownsville	Fresh.
5	......do	......do	do.
6	......do	......do	do.

Nitzsch says of *S. cunicularia* that "it has twenty-four remiges, of which ten are on the hand; the first equals the fifth; the second between the fourth and fifth; the third somewhat longer than the fourth." Since he does not mention the *real first* primary, it is necessary to add one to each of these figures in order to get the formula as he meant it. Reversing the notation, it then becomes 8, 7, 9, 6=10, 5, 4, 3, 2, 1, 11, which agrees substantially with what I have given. Although Nitzsch allows the genus only fourteen secondaries, both Dr Shufeldt and I found fifteen.

Genus GLAUCIDIUM.

The pterylosis of this genus is very similar to that of *Micropallas* and *Speotyto*, but the infra-mandibular region is not at all thickly feathered and there are distinct apteria along the rami of the lower jaw. The upper cervical tract is broader than usual and posteriorly divides so very slightly that the fork is not clearly defined at all, while the dorsal tract extends farther forward than in *Asio*, although it does not quite reach the end of the cervical. The humeral tracts are not very broad, being narrower than the upper cervical. The femoral tract is well developed and the tarsus is feathered only as far as the somewhat hairy toes. Beneath *Glaucidium* agrees closely with *Asio*, although the ventral tracts are not quite so clearly marked on the breast. The formula for the primaries is as follows: 7, 6, 8, 5, 4=9, 3, 2, 1, 10, 11. Two of the specimens examined had fourteen and the other two fifteen, secondaries, while there are, as usual, twelve rectrices.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Glaucidium phalænoides	Brownsville, Tex	Fresh.
2	......do	......do	do.
3	......do	......do	do.
4	......do	......do	do.

Genus SYRNIUM.

The only specimen of this genus which I have examined agrees very well in the general pterylosis of the body with *Asio accipitrinus*, but dif-

fers on the head in a few details. The lower cervical tract is clearly defined on the chin instead of being indistinctly scattered, while on the crown the longitudinal rows are so close together and so similar that the general effect is like the uniform feathering of *Speotyto*. The feet are fully feathered to the base of the toes and the latter are more or less feathered above. The wings had been clipped but there were apparently sixteen secondaries.

Specimen examined.

No.	Name.	Collection.	Condition.
1	Syrnium nebulosum................	U. S. Nat. Mus	Alcoholic.

Genus ASIO.

This genus seems to me to show, best of all the owls I have examined, the typical Strigine pterylosis, and this is especially true of *A. accipitrinus*. The dense feathering of the anterior part of the head; the apterium above the eye; the four distinct longitudinal rows on the

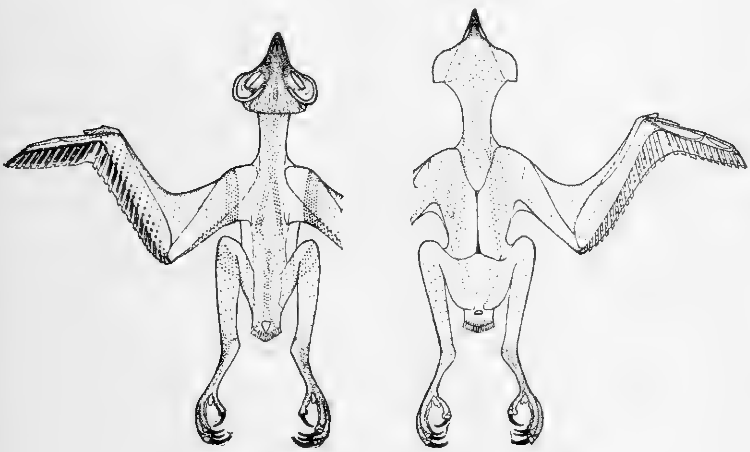


Fig. 9. Fig. 10.

PTERYLOSIS OF ASIO ACCIPITRINUS.

crown, a pair on each side; the broad upper cervical tract rapidly narrowing and deeply forked; the strong humeral tract and parapterum on each wing; the rather weak dorsal tract indistinct at first, but clearly defined posteriorly and forking to include the naked oil gland; the strong femorals with numerous scattered feathers between them and the dorsal; the feathering of the feet almost to the claws; the very sparsely feathered infra-mandibular space; the deeply forked lower cervical tract; the very evident contour feathers on the upper outer

part of the breast, and chiefly the complete separation on the breast of the sternal and ventral tracts, all make up the typical pterylosis of the owls and are clearly shown in figs. 9 and 10. *Asio wilsonianus* does not show these points as well, or at least the specimens which I was able to obtain did not show them, but as they were not in very good condition it is possible that perfect material will show more complete agreement with *Asio accipitrinus.* The species of *wilsonianus* examined did not show clearly the longitudinal arrangement of feathers on the crown, although the head was not uniformly feathered as in *Speotyto;* the femoral tract was no longer a true femoral, but scarcely reached the femur at all, being confined to the back of the tibia (this may be easily understood by imagining the femoral tract in fig. 10 to be moved down on the tibia one-eighth of an inch nearer the tarsus); on the front of the tibia the feathering was so very dense that there was a very distinct tract there. The two species agreed in possession of *fifteen* secondaries and in the following formula for the primaries: 9, 8, 7, 10=6, 5, 4, 3, 2, 1, 11.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Asio wilsonianus	Amherst, Mass	Fresh.
2	......do	U. S. Nat. Mus	Alcoholic.
3	Asio accipitrinus	Brownsville, Tex	Fresh.
4	......do	......do	do.
5	......do	......do	do.
6	......do	......do	do.
7	......do	......do	do.

Nitzsch says of *Strix brachyotus:* "Twenty-four remiges, the second the longest, the first somewhat shorter than the third." Making the same addition and reversion as we found necessary under *Speotyto,* this formula becomes 9, 8, 10, 7, 6, 5, 4, 3, 2, 1, 11, which is almost the same as that I have given. He only credits the genus with fourteen secondaries, while I have always found one more.

Genus MEGASCOPS.

Except for the peculiar difference in the arrangement of the longitudinal rows on the head, the pterylosis of this genus is very much like that of *Asio.* This difference is very well shown in the plates and may be briefly characterized thus: In *Asio* the longitudinal rows are central, while in *Megascops* they are lateral. On the infra-mandibular space the feathers are more numerous in the screech owls, but other distinctions are not obvious. There are fourteen secondaries, and the eleven primaries rank as follows: 7=6, 8, 5, 9, 4, 3, 2, 10=1, 11. The feet were more heavily clothed in feathers, though the same surface was

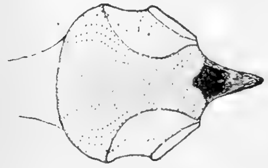


Fig. 11.

HEAD OF MEGASCOPS ASIO.

Showing arrangement of longitudinal rows.

covered, in the specimen from New York State than in *kennicotti*, and in the latter more than in *mc callii*.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Megascops asio	Pittsburg, Pa	Fresh.
2	......do	Rochester, N. Y	do.
3	Megascops asio mc callii	Brownsville, Tex	do.
4	Megascops asio kennicotti	U. S. Nat. Mus	Alcoholic.

Nitzsch says of *Scops asio*: "Twenty-two remiges * * * the fourth the longest, the third equal to the sixth, the second to the seventh, and the first scarcely to the ninth." This gives the formula 7, 6, 8=5, 9=4, 3, 2, 10, 1, 11, which is about what I have given. He only allows twelve secondaries, while I have always found fourteen.

Genus GYMNOGLAUX.

Among the other owls from the National Museum, there was a representative of this genus from Puerto Rico, but its specific identity was not known. It agreed in nearly all particulars with *Megascops*, the only important difference being in the feathering of the feet. The longitudinal rows on the head were arranged as in *Megascops*, although they were not quite so clearly defined. The tibia was heavily feathered in front, but the tarsus was only clothed about half-way down and was bare on the sides and behind, so that it was more extensively denuded than in any other owl examined. The primaries had unfortunately been cut, so that their formula can not be given, but there seemed to be only thirteen secondaries, a small number for an owl.

Specimen examined.

No.	Name.	Collection.	Condition.
1	Gymnoglaux sp. ?	U. S. Nat. Mus	Alcoholic.

Genus STRIX.

This genus shows a greater variation from the normal owl-type than any other of which I know and would deserve a figure if it had not already been so well figured by Nitzsch. It differs from *Asio* in the following particulars: The head is more uniformly feathered above and shows no signs of longitudinal rows, but the infra-mandibular region is scarcely feathered at all, except for the very narrow lower cervical tract, which begins at the base of the gonys and extends nearly to the furcula before forking widely. It is, however, slightly divided for some distance before it actually forks, so that the upper part of each branch is abruptly

wider than the lower, although there is no true inner branch given off. The upper cervical tract is very narrow, while the humerals are narrower than in any other genus and the parapterum is weak. The femorals are strong, but very diffuse, and are scattered over most of the femur. The feet are not feathered quite to the toes, but the latter are very hairy. The sternal tract is fused with the ventral, not only at its origin near the furcula, but also at the other end of the breast, so that the tracts are really one; very broad on the sternum, and containing a longitudinal apterium, and becoming abruptly narrow on the belly. The hypopterum is very strongly marked, and the hook connecting it with the sternal tract is composed of larger feathers, and they are much more numerous than in the other owls. Indeed, the whole breast is much more thickly feathered than in *Asio*. Another remarkable peculiarity is the formula for the comparative lengths of the *rectrices*. In all the other owls the middle pair of tail-feathers is the longest and the external pair shortest, so that the formula is 1, 2, 3, 4, 5, 6. In *Strix*, however, this is exactly reversed, the outer pair being the longest and the formula reading 6, 5, 4, 3, 2, 1. There are fifteen secondaries and the primaries rank as follows: 9, 8, 10, 7, 6, 5, 4, 3, 2, 1, 11.

Specimens examined.

No.	Name.	Collection.	Condition.
1	Strix pratincola	Brownsville, Tex	Fresh.
2	......do	......do	do.

Nitzsch says of *Hybris flammea:* "Twenty-four remiges, the three first about equally long, but the second is really the longest." This formula is the same as what I have just given. There are, however, fifteen secondaries, instead of fourteen, as Nitzsch says.

COMPARISON OF THE TWO GROUPS.

Before entering on a detailed comparison of the two groups which we have been examining, it will set some of the facts more clearly before us if we arrange them in tabular form.

Comparison of the groups.

Group.	Number of primaries.	Number of feathers in the alula.	Aftershaft.	Condition of oil-gland.	True down.	Condition of wing.
Caprimulgi	10	3	Present	Bare	Wanting	Aquincubital.
Striges	11	4	Wanting	....do	....do	do.

Comparison of the genera.

Genus.	Pterylosis of the crown.	Rictal bristles.	Primary formula.
Phalænoptilus	Longitudinal rows	Present	
Antrostomus	do	do	8=9, 7=10, 6, 5, 4, 3. 2, 1.
Nyctidromus	do	do	8. 9, 7. 10, 6, 5, 4, 3, 2, 1.
Chordeiles	do	Wanting	10, 9, 8, 7, 6, 5, 4. 3, 2, 1.
Micropallas	Uniform	do	
Speotyto	do	do	9=8, 7, 6=10. 5. 4, 3, 2, 1, 11.
Glaucidium	do	do	7, 6, 8, 5, 4, 9, 3, 2, 1, 10, 11.
Asio	Longitudinal rows	do	9, 8, 7, 10=6, 5, 4, 3, 2. 1, 11.
Syrnium	do	do	
Megascops	do	do	7, 6, 8, 5, 9, 4, 3, 2. 10, 1, 11.
Gymnoglaux	do	do	
Strix	Uniform	do	9, 8, 10, 7, 6, 5, 4, 3, 2, 1, 11.

Genus.	Number of secondaries.	Pterylosis of the feet.	Number of rectrices.	Formula for rectrices.
Phalænoptilus	12	Bare	10	1, 2, 3, 4, 5.
Antrostomus	12	Tarsus feathered halfway down in front	10	1, 2, 3, 4, 5.
Nyctidromus	12	Bare	10	1, 2, 3, 4, 5.
Chordeiles	13	Tarsus feathered halfway down in front	10	5, 4, 3, 2, 1.
Micropallas	13	Fully feathered	10	1, 2, 3, 4, 5.
Speotyto	15	Feathered to base of toes	12	1. 2, 3, 4, 5, 6.
Glaucidium	14 or 15	do	12	1, 2, 3, 4, 5, 6.
Asio	15	Fully feathered	12	1, 2, 3, 4, 5, 6.
Syrnium	16	Almost fully feathered	12	1, 2, 3, 4, 5, 6.
Megascops	14	Fully feathered	12	1, 2, 3, 4. 5, 6.
Gymnoglaux	13	Tarsus feathered halfway down in front	12	1, 2, 3, 4; 5, 6.
Strix	15	Feathered to toes	12	6, 5, 4, 3, 2, 1.

Having thus set the more important facts before us in a condensed and therefore convenient form, let us see what inferences, if any, can be drawn from them. In order to estimate correctly the value of likenesses and the weight of differences, one must first consider the relative importance of the different pterylographical characters in any two groups. We may safely assert that the most importance attaches to the fundamental plan of the pterylosis, while slight variations carry little weight. This is to be inferred from the uniform pterylosis of clearly defined groups such as the Grouse or even the Passeres. Next to this I should rank the condition of the wing, whether aquincubital or not, and the number of rows of coverts and then the condition of the oil-gland tuft, aftershaft, and down. The number of rectrices, remiges, and feathers in the alula are much more variable and depend to some extent perhaps on the size of the bird, but of course agreement in these details would carry more weight than differences. Less valuable would be the denudation of the tarsus and tibia, which is more or less dependent on the habits of each species, while the least important of all characters is the presence or absence of peculiar feathers or crests, because these often differ even in the two sexes of the same species. Estimating the value of the characters in this way, let us now examine, under the following four heads, the comparative pterylography of the two groups before us: (1) fundamental plan of pterylosis, together with its variation in detail; (2) arrangement of the feathers of the wing; (3) aftershafts, oil gland, and down; (4) tail.

Fundamental plan and variation in detail.—In regard to the fundamental plan of the pterylosis, it needs only a glance at the figures to show us that while dorsally the two groups are very similar, there is ventrally at least one important difference. On the head the feathering is much more dense and uniform in Striges than in Caprimulgi, but there are nevertheless signs in the former group of a tendency towards a less uniform covering, as witness the longitudinal rows of *Asio* and *Megascops.* Furthermore, in *Chordeiles*, there is a much more uniform feathering of the infra-mandibular region than in any owl except possibly *Speotyto.* There is no constant difference between the two groups in the upper and lower cervical tracts which are always narrow and clearly forked. The dorsal tract is practically the same in both, varying indeed in the different genera as to its extent and its union with the forks of the upper cervical. The strong humerals with an evident parapterum are also common to the two groups and the peculiarly placed femoral tract is likewise characteristic of both, which is the more remarkable as the tibia is always much more heavily feathered in Striges. As a rule, too, the owls have the feet much more fully clothed, but as much of the tarsus is bare in *Gymnoglaux* as in *Antrostomus* so that this slight difference is by no means constant. On the ventral surface the two groups agree in several minor details such as a strong hypopterum and hook, connecting with the sternal tract, and the numerous scattered feathers on the upper outer corner of the breast and on the shoulder, including a connection between the lower cervical and the humeral tracts. But it is on the breast that we find the first real difference in the fundamental plan, and this demands a careful examination. In the Caprimulgi, the lower cervical after forking continues on each side as a single tract, forming on the breast a broad and strong sternal, and on the belly, after narrowing abruptly, the much weaker ventral tract. In the Striges on the other hand, the lower cervical, after forking, forms on each side of the breast the well-marked sternal tracts, but does not continue down on the belly to form the ventrals. These are, on the contrary, in the typical Strigine pterylosis, entirely separate from the other tracts at least as far up as the furcula and owing to their weakness at that point their union with the sternals is often very indistinct. It will be at once seen that this difference is really important, but when we consider the condition of these tracts in *Strix*, we find an arrangement that is really intermediate between the two groups, and this gives us a hint as to how the Caprimulgine form may have been derived from such an arrangement as occurs at present in the owls. In *Strix*, as has already been pointed out, not only do the ventral and sternal tracts fuse clearly near the furcula, but owing to the slight outward curve of the former and a more abrupt inward curve of the latter, the two unite at the posterior extremity of the sternals so as to form in reality one broad tract on the breast, containing a longitudinal apterium. It

will be easily seen that should this fusion increase at each end and continue until the apterium had disappeared, we would arrive at the Caprimulgine condition. May it not be true that in this way the single tract of the Caprimulgi has been formed? At any rate there is nothing inherently improbable in the idea. If this be granted the conclusion is inevitable that the fundamental plan of the pterylosis was originally the same in both groups, and since in those minor points in which they differ (such as the longitudinal rows on the head in the Caprimulgi and the feathering of the tarsus in the Striges) there are numerous intergradations, there is certainly reason to admit the possibility of some relationship. It may be mentioned here that *Strix* shows another peculiarity which is not unlike one of the features of *Chordeiles.* It will be remembered that the lower cervical fork of the latter genus shows a prominent inner branch and although this is not found in any owl, yet the peculiar formation of the tract in *Strix* gives us a hint as to its possible origin. The above hypotheses in regard to the origin of the single sternal-ventral tract in the Caprimulgi and the inner cervical tooth in *Chordeiles* seem to indicate greater specialization on the part of this group and it is worth while to bear this in mind as we consider the other characters to be compared.

Arrangement of the feathers of the wing.—Since the wing is one of the most characteristic organs of a bird, and since variations in the arrangement of its feathers are almost endless even within the limits of well-defined groups, similarities in these points must carry considerable weight, especially when these likenesses are in such details as the comparative length of the primaries. If we compare the wing of an owl with that of one of our goatsuckers, we find substantial agreement in several points, but some apparently important differences in others. Both agree in being aquincubital, a character which seems to be of the greatest importance. They agree further in the number of rows and distribution of the coverts and even fairly well in the comparative lengths of the primaries. Thus among the Caprimulgi, the eighth and ninth are about equal and are longest; then follow the seventh and tenth (about equal), and the sixth, very little shorter, and then 5, 4, 3, 2, 1. *Chordeiles* (according to Coues) has the tenth equal to the ninth and the rest in regular succession. Among the owls examined there are three groups; *Asio* and *Speotyto* agreeing very closely with the whip-poor-will as above given, the eighth and ninth being about equal, seventh next, sixth and tenth (equal), and the rest in regular order; *Strix* differing from these and approaching *Chordeiles* in the greater length of the tenth primary, which is longer than the seventh and almost equals the ninth; *Glaucidium* and *Megascops* showing a very different arrangement with the seventh longest and the tenth about equal to the first. Striges, however, possess the eleventh primary in a rudimentary condition, while it has completely disappeared in the Caprimulgi. The latter have only three feathers in the alula,

while the owls have four. The number of secondaries varies in the different genera, but it is almost always greater in the owls. It will be noticed that these differences are all numerical and that the smaller number is always the characteristic of the Caprimulgi. It is well known that in the evolution of birds there has been a distinct tendency towards a reduction of the number of remiges and this tendency has been very marked in the specialization of many groups of small land birds. This reduction takes place not only at the upper or inner end of the forearm, thus decreasing the number of secondaries, but also at the outer end of the hand, thus decreasing the number of primaries. The former is much the more common and extensive method, so that the number of secondaries may vary between six and forty; while the latter is limited to one or two feathers only, the number of primaries at least in Carinate birds, varying between ten and twelve.* We thus see that in the structure of the wing, the Caprimulgi show a greater specialization than the Striges, although the arrangement of the coverts, the absence of the fifth secondary, and the comparative lengths of the primaries would seem to indicate that the original plan of the wing was the same in both groups. This is in line with the conclusion to which our examination of the general pterylosis had brought us and the consideration of the remaining characters may throw still more light on the subject.

The presence of aftershafts, oil gland, and down.—In the general structure of the plumage there is a superficial resemblance between the owls and goatsuckers, but a careful examination does not altogether bear this out. The greatest difference lies in the presence of an aftershaft on the feathers of the Caprimulgi which is entirely lacking in Striges. Although stronger in *Nyctidromus* than *Chordeiles*, it is, even in that genus, very weak, although I have always found it present. In the owls, however, it is uniformly absent and I have found no trace of it in any of the specimens which I have examined. This difference can not, therefore, be easily explained away, at least not until we know more of the origin and function of the aftershaft and are better acquainted with the pterylography of all the genera. I have already spoken of the peculiar length of the calamus in the large wing and tail feathers of the Caprimulgi, but I did not find the same structure clearly shown among the owls, except in *Glaucidium*, where it was as evident as in *Nyctidromus*. Down feathers are very rare in both groups, if present at all, and I found no trace of an oil-gland tuft in either, although Nitzsch speaks of finding a trace of it in *Strix*.

Number and length of feathers in the tail.—What has been said above in regard to the reduction of the number of remiges in birds is also true of the rectrices, although the evidence is less satisfactory. However, it will hardly be disputed that the presence of ten rectrices in the Caprimulgi indicates greater modification than the presence of twelve

* See Dr. Gadow's interesting article in Proc. Zool. Soc., 1888, p. 655.

in the owls. This difference in number might have been something of a difficulty in showing any connection between the two groups were it not for the interesting discovery that *Micropallas* possesses only ten, a fact which seems to have previously escaped notice. Another thing of interest in regard to the tail is that while in both Striges and Caprimulgi it is the rule for the middle pair of rectrices to be longest, there is an exception in each group; among the former *Strix*, and in the latter, *Chordeiles*, has the outer pair longest.

CONCLUSIONS.

Having thus compared in detail the pterylographical characters of both Caprimulgi and Striges, as far as the material at hand would allow, I may justly be permitted to draw a few inferences from the facts before me. It can hardly be denied that these facts indicate a certain degree of affinity, and although to me this relationship seems quite close, of course it is well understood that conclusions based on one set of facts will often be overturned by another set and are, therefore, unreliable. Judging from the wings and tail, the united sternal and ventral tracts, and the striking longitudinal arrangement of the feathers on the crown, there can be little doubt that the Caprimulgi are the more decidedly modified of the two groups. In each one of these particulars, moreover, there are owls almost as fully modified, yet they do not combine them as do all of the Caprimulgi. Thus, *Micropallas* has only ten rectrices, but the head is uniformly feathered and the ventral tract is distinct, while *Strix* shows a partial union of the sternal and ventral tracts, but has twelve rectrices and a closely feathered crown. We may thus reasonably conclude that the common ancestors of the two groups were rapacious birds much more like owls than goatsuckers and probably more or less nocturnal in their habits. They had a well-feathered head, a widely forked upper cervical tract, separate sternal and ventral tracts, a peculiarly situated femoral tract, twelve rectrices, of which the middle pair were longest, and twenty-six or more remiges, of which eleven were on the hand. The plumage probably possessed an aftershaft and the oil gland was bare, while the tarsus may have been feathered. From this extremely hypothetical stem, there soon arose birds more crepuscular than nocturnal and insectivorous rather than carnivorous. These were the immediate ancestors, of the Caprimulgi and soon lost the first primary, one pair of rectrices, and several secondaries. In them also the ventral and sternal tracts fused and the feathers of the head condensed into longitudinal rows, while the feathers of the tarsus began to disappear. Thus the general Caprimulgine pterylosis arose by what will at once be seen as a process of condensation, possibly due to the need of greater lightness and speed for the capture of their insect prey. *Phalænoptilus* shows the most perfect development of this Caprimulgine form and so is the most modern descendent of these hypothetical ancestors. *Chordeiles*

seems to have branched off from the Caprimulgine form very early and probably by becoming diurnal to a greater degree. Thus having little need of sensitive rictal bristles, it lost them, while the wing and tail were also modified. Among the owls the variation from the supposed ancestral form has been more spasmodic and the direct progress much less, but the pterylography of even the American forms is too little known to draw any satisfactory conclusions. It is certainly a very curious fact that *Strix* shows some variations which are completely parallel to those of *Chordeiles*; thus, the outer pair of tail feathers is the longest, the tenth primary almost equals the ninth, the peculiar forking of the lower cervical tract gives a hint of the origin of the inner branch of *Chordeiles*, and, finally, the partial fusion of the sternal and ventral tracts is decidedly Caprimulgine. Whether this indicates a nearer approach to that hypothetical, lost, parent form is, to say the least, doubtful. More probably *Strix* has varied from the Strigine stem in the same way, though to a greater degree, perhaps, than *Chordeiles* has from the Caprimulgine.

The conclusion, then, to which this study of their pterylography has brought me is that the Caprimulgi are related to Striges, and not very distantly either—probably a branch from the early part of the Strigine stem. Dr. Sharpe, in his address at Budapest on "Recent Attempts to Classify Birds," says that the idea that Caprimulgi and Striges are nearly allied "is now scouted," but he admits that the nearest approach to the latter is in *Steatornis*. Garrod, in his very interesting account of the latter genus,* concludes that it resembles Striges much more than Caprimulgi, while Parker † considers its resemblance to either group as being purely analogous, and so forming no connecting link between the two. The weight of argument perhaps, of authorities certainly, is thus directly opposed to the conclusions to which my observations had led me. It must be, therefore, as above stated, that a conclusion based on one set of facts only is eminently unreliable and should be set aside if the other characters are all against it. However this may be, I can only say that a comparative study of the pterylography of the two groups as represented in North America most certainly shows some surprising similarities. Perhaps, however, it is only an extraordinary case of what may be called "analogous variation."

*Proc. Zool. Soc., London, 1873, p. 526.
† Opp. cit., 1889, p. 161.

THE BOX TORTOISES OF NORTH AMERICA.

By W. E. Taylor.

In the discussion of the genus *Terrapene** it is my purpose to present, in detail, the osteological characters and the geographical distribution of the genus. In doing this I have had the privilege of examining a great number of specimens, representing approximately the whole distribution of the genus in the United States and Mexico.†

History and nomenclature.—From very early times systematic zoologists have mentioned the common box tortoise, under various names, as occurring in North America. Over sixty authors have given one or more species as found in various localities. But most of these writers merely mention the names of the species, while localities, if given, are indefinite. A full discussion of these writings would be out of place in this article, and hence I content myself with barely mentioning a few of the most important papers, the authors of which have reported new species or proposed new names.

Edwards, in 1751, gives a good figure of *Terrapene carolina.*

Linnæus, in his tenth edition of the Systema Naturæ, 1758, mentions *Testudo carolina* as from Carolina. His description was taken from Edwards.

Gray, in 1844, described *Emys kinosternoides*, which may be *Terrapene triunguis*, Agassiz.

Gray, in the Proceedings of the Zoological Society of London, 1849, describes *Onychotria mexicana* as from Mexico.

Agassiz, in his Contributions to the Natural History of the United States, 1857, describes *Cistudo virginea* (Gmelin), *Cistudo triunguis*,

*This is the generic name, which has to be used for the American box tortoises. *Cistuda*, Fleming, 1822, is a synonym of *Terrapene*, Merrem, 1820.

†The author is under special obligations to Dr. G. Baur, Assistant Professor, University of Chicago, for material aid in the preparation of this paper, the synonymies being, for the greater part, prepared from his manuscripts, and to the authorities of the U. S. National Museum for the loan of valuable specimens. He has also to thank the following gentlemen for specimens from various parts of the country, viz: Prof. H. Garman, Prof. S. S. Maxwell, Prof. Benjamin B. Penfield, Dr. O. P. Hay, Mr. Gustave Kohn, Mr. Julius Hurter, Mr. Roy R. Larkin, Prof. Theo. D. A. Cockerell, Prof. H. B. Duncanson, Dr. Adolph Meyer, and Prof. J. D. Bruner.

Cistudo ornata, and *Cistudo major*, the first being *Testudo carolina* of Linnæus, while the last three were recognized as new species.

Strauch, in his Vertheilung der Schildkröten, 1865, included all of our American forms under *Terrapene carinata*, Linnæus.

Cope, in his Check-List of North American Batrachia and Reptilia, 1875, recognizes *Cistudo clausa*, subspecies *clausa* (Gmelin and Holbrook), *C. clausa*, subspecies *triunguis*, and *C. ornata*. He placed *Testudo carolina* of Linnæus under the genus *Testudo*.

True, in Yarrow's Check-List of North America Reptilia and Batrachia, 1883, recognizes *Cistudo carolina*, *C. carolina triunguis*, and *C. ornata*.

Boulenger, in his Catalogue of Chelonians in the British Museum, 1888, admits but two species, as follows: *Cistudo carolina*, *C. carolina* var. *kinosternoides*, *Cistudo carolina* var. *major*, *C. carolina* var. *mexicana*, and *C. ornata*.

Baur, in the American Naturalist, 1893, after making a study of the osteology of *Terrapene*, adopts the following species: *Terrapene major*, *T. carolina*, *T. mexicana*, *T. triunguis*, and *T. ornata*.

By continuing the work of Dr. Baur, and adding to the collections already made by him, I am able to confirm his observations, and, at the same time, to add a new species.

I recognize the following species: *Terrapene major*, *T. bauri*, *T. carolina*, *T. mexicana*, *T. triunguis*, and *T. ornata*.

Not until within the last few years has the osteology of our forms been carefully studied. Gray overlooked the rudimentary quadrato-jugal in *T. carolina*. Agassiz, in his characterization of the genus, speaks of the temporal arch as "either cartilaginous or only partially ossified," forgetting the fact that *T. major*, described by him, possesses a well-developed zygomatic arch.

Boulenger gives the absence of a bony temporal arch as characteristic for *Terrapene*.

Brühl gives a figure of the skull of *Terrapene carolina*, but overlooked the quadrato-jugal.

Baur, in the Zoologischer Anzeiger for 1888, No. 296, first pointed out the fact that *T. carolina* possesses a rudimentary quadrato-jugal, contrary to the opinion held by Gray and others. Later, in Science, No. 426, 1891, he gave the osteological characters of *Terrapene major*, *T. carolina*, and *T. ornata;* and still later, in the American Naturalist, 1893, the complete osteological characters and general descriptions of *T. major*, *T. carolina*, *T. mexicana*, *T. triunguis*, and *T. ornata* were given.

The geographical distribution of *Terrapene* has never been completely worked out. Most authors have merely given a few localities or the range of each species in a general way.

Agassiz, in 1857, gives *T. carolina* (*Cistudo virginea*) as the north eastern type and erroneously states that it "has the most extensive range" of the genus. He also mentions *Terrapene* (*Cistudo*) *triunguis*

as the western and southwestern type, and *Terrapene* (*Cistudo*) *ornata* as the northwestern type. Owing to the limited data accessible he failed to recognize that the last-named species is the western form, from the Yellowstone to the Rio Grande. He also mentions *Terrapene* (*Cistudo*) *major* as the southern and southeastern type of the genus.

Cope, in 1875, states that *Terrapene carolina* is found in the "Eastern region and Louisianian and Floridian districts;" *T. triunguis* in the "austroriparian region to Georgia, eastern Pennsylvania," and *T. ornata* in the "Central region."

Baur, in 1893, gives the geographical distribution of the species as follows: *T. major*, "Southern States;" *T. carolina*, "Eastern States to Indiana;" *T. mexicana*, "Mexico;" *T. triunguis*, "Louisiana, Arkansas, Indian Territory, Mississippi, Georgia;" *T. ornata*, "Central States."

The writer's notes on the geographical distribution of *Terrapene* will be given under a separate heading.

Genus TERRAPENE, Merrem.

1820.—*Terrapene*, MERREM, Versuch eines Systems der Amphibien, p. 27 (type, *Testudo clausa*, GMELIN=*T. carolina*, LINNÆUS).—BAUR, Zool. Anz., 1888, No. 296; Science, XVII, 1891, p. 190; Proc. Amer. Philos. Soc., 1892, p. 245.

1822.—*Cistuda*, FLEMING, Philosophy of Zoology, II, p. 270.

1832.—*Diclida* (part), RAFINESQUE, Àtlantic Journal, I, p. 64 (in Analyse de la Nature, 1815, name only).

1835.—*Pyxidemys* (part), FITZINGER, Ann. Wiener Mus., I, p. 123.

1844.—*Emyoides*, GRAY, Catalogue of Tortoises in British Museum, p. 27.

1849.—*Onychotria*, GRAY, Proc. Zool. Soc. London, 1849, p. 17.

1857.—*Cistudo*, AGASSIZ, Contributions to the Natural History of the United States, I, p. 444.—BOULENGER, Catalogue of the Chelonians in British Museum, 1889, p. 114.—BAUR, Proc. Amer. Philos. Soc., 1892, p. 44.

KEY TO THE SPECIES OF TERREPENE.

I. Three digits on the hind foot.
  1. Zygomatic arch complete. Webs absent. Phalanges on the fore foot 2-3-3-3-2, hind foot 2-3-3-2-1 .... BAURI, p. 576.
  2. Zygomatic arch incomplete. Webs absent.
    a. Number of phalanges in the fore foot 2-3-3-2-2, hind foot 2-3-3-3-1. Carapace tectiform .... MEXICANA, p. 579.
    b. Number of phalanges in fore foot 2-3-3-2-2, hind foot 2-3-3-2-1. Carapace not tectiform .... TRIUNGUIS, p. 580.

II. Four digits on the hind foot.
  1. Zygomatic arch complete. Webs distinct. Phalanges in the fore foot 2-3-3-3-2, hind foot 2-3-3-3-2 .... MAJOR, p. 575.
  2. Zygomatic arch rudimentary. Digits slightly webbed. Phalanges in the fore foot 2-3-3-3-2, hind foot 2-3-3-3-2. Carapace keeled .. CAROLINA, p. 577.
  3. Zygomatic arch absent. Webs absent. Phalanges in the fore foot 2-2-2-2-2, hind foot 2-3-3-3-1. Carapace not keeled .... ORNATA, p. 581.

TERRAPENE MAJOR (Agassiz).

1857.—*Cistudo major*, AGASSIZ, Contributions to the Natural History of the United States, I, p. 445 (type in Mus. Comp. Zool., Cambridge, Mass.; locality of type, Mobile, Ala.).—GARMAN, Bull. Essex Inst., XVI, 1884, p. 10.

1865.—*Terrapene carinata* (part), STRAUCH, Mém. Acad. Sci. St. Petersb. (7), VIII, No. 13, p. 46.

1870.—*Cistudo carolina* var. *major*, GRAY, Supplement to the Catalogue of Shield Reptiles, p. 19.—BOULENGER, Catalogue of Chelonians in British Museum, 1889, p. 117.

1891.—*Terrapene major*, BAUR, Science, XVII, 1891, p. 190; Amer. Natural., XXVII, 1893, p. 677.

Quadrato-jugal well developed; zygomatic arch complete, and always present and relatively wider and more fully developed than in *T. bauri*. Maxillæ distinctly notched. Upper branch of the scapula considerably longer than the inner branch (endo-scapula); digits with distinct well-developed webs. Number of phalanges in the forefoot, 2–3–3–3–2; hind foot, 2–3–3–3–2. Number of claws in the hind foot, 4.

Carapace oblong in horizontal outline; transverse outline semicircular. Anterior margin but slightly curved; moderately compressed above and median ridge distinct. The width of the carapace compared to length varies from 10–12 to 10–14. First pleural plate more than half as wide as long. Ground color varying from black, yellowish olive or dark brown to very light dingy brown. The yellow spots are arranged in radiating lines but are not connected. The plastron is usually of a straw-yellow color with the dermal plates more or less faintly bordered with black or dark brown.

This species is found in regions adjacent to the Gulf coast of Florida, Alabama, Louisiana, and Texas.

List of specimens.

No.	Collector.	Collection.	Locality.
1	G. Kohn		New Orleans, La.
2	G. Kohn		Mandeville, La.
3	G. Kohn		Galveston, Tex.
4	Dr. G. Baur*		Nashville, Tenn.

*Not seen by the writer, but examined by Dr. Baur with reference to the points discussed in this paper.

TERRAPENE BAURI, new species.

Quadrato-jugal well developed; zygomatic arch complete, though not as wide as in *T. major*. Webs absent. Number of phalanges in the forefoot, 2–3–3–3–2; hind foot, 2–3–3–2–1. Number of claws on the hind foot, 3.

Carapace semicircular in transverse outline, imperfectly oblong in horizontal outline. Median ridge and keel distinct. First pleural plate more than three times as long as wide. Ratio of width to length of the carapace approximately 10 to 13.

Ground color of the carapace dark brown, sometimes slightly olive, marked with yellow, arranged in radiating lines rather than single spots; keel yellow. The markings of the carapace bear a very close resemblance to the extreme western species *T. ornata*, a species from which it is entirely separated geographically. Plastron yellowish with but few markings.

The type (No. 8352, U.S.N.M.) was collected in Florida by F. B. Meek. The species is named for Dr. Baur, who first noticed the peculiarities of the type, but having only the one specimen considered it as an exceptional individual of *T. triunguis.*

List of specimens.

No.	Collector.	Collection.	Locality.
1	F. B. Meek	No. 8352, U. S. N. M	Florida.

TERRAPENE CAROLINA (Linnæus).

1758.—*Testudo carolina,* LINNÆUS, Systema Naturæ, 10 ed., I, p. 198 (from EDWARDS; locality, South Carolina); 12 ed., I, 1766, p. 852.—SCHNEIDER, Naturgeschichte der Schildkröten, 1783, p. 334.—GMELIN, Systema Naturæ, I, ii, 1788, p. 1041.—BONNATERRE, Tableau Encyclopédique et Méthodique, Erpétologie, 1789, p. 28.—DONNDORFF, Zoologische Beyträge, III, 1798, p. 20.

1758.—*Testudo carinata,* LINNÆUS, Systema Naturæ, 10 ed., I, p. 198; 12 ed., I, 1766, p. 353.—SCHNEIDER, Naturgeschichte der Schildkröten, 1783, p. 361.—LACÉPÈDE, Histoire Naturelle des Quadrupèdes Ovipares et des Serpens, I, (Synops. méth.), 1788, p. 164.—BONNATERRE, Tableau Encyclopédique et Méthodique, Erpétologie, 1789, p. 28.—DONNDORFF, Zoologische Beyträge, III, 1798, p. 27.—SHAW, General Zoology, III, pt. i, 1802, p. 35.

1788.—*Testudo clausa,* GMELIN, Systema Naturæ, I, ii, p. 1042.—SCHOEPFF, Historia Testudinum, 1792, p. 32, Pl. VII.—DONNDORFF, Zoologische Beyträge, III, 1798, p. 27.—SHAW, General Zoology, III, pt. i, 1802, p. 36, Pl. VII.—DAUDIN, Histoire Naturelle des Reptiles, III, 1803, p. 207, Pl. XXIII, figs. 1, 2.—LE CONTE, Annals Lyc. Nat. Hist., New York, III, 1830, p. 124.

1788.—*Testudo brevi-caudata,* LACÉPÈDE, Histoire Naturelle des Quadrupèdes Ovipares et des Serpens, I (Synops. méth.), p. 169.

1789.—*Testudo incarcerata,* BONNATERRE, Tableau Encyclopédique et Méthodique, Erpétologie, p. 29.

1789.—*Testudo incarcerata-striata,* BONNATERRE, Tableau Encyclopédique et Méthodique, Erpétologie, p. 29.

1803.—*Testudo virgulata,* DAUDIN, Historie Naturelle des Reptiles, III, p. 201, Pl. XXIII, figs. 3, 4.

1812.—*Emys clausa,* SCHWEIGGER, Königsberg. Arch. Naturwiss., I, pt. i, pp. 315, 438.—WAGLER, Natürliches System der Amphibien, p. 138.—SCHLEGEL, Fauna Japonica, Reptilia, 1833, p. 65.

1812.—*Emys virgulata,* SCHWEIGGER, Königsberg. Arch. Naturwiss., I, pt. i, pp. 316, 441.

1812.—*Emys schneideri,* SCHWEIGGER, Königsberg. Arch. Naturwiss., I, pt. i, pp. 317, 442.

1820.—*Terrapene clausa,* MERREM, Versuch eines Systems der Amphibien, p. 28.—FITZINGER, Neue Classification der Reptilien, 1826, p. 45.

1825.—*Terrapene carolina,* BELL, Zool. Journ., II, p. 309.—BAUR, Science, XVII, 1891, p. 190; Amer. Natural., XXVII, 1893, p. 677.

1825.—*Terrapene nebulosa,* BELL, Zool. Journ., II, p. 310.

1825.—*Cistudo clausa,* SAY, Journ. Acad. Nat. Sci. Phila., IV, pt. ii, pp. 205, 214.—BONAPARTE, Cheloniorum Tabula Analytica, 1836, p. 6.

1826.—*Terrapene virgulata,* FITZINGER, Neue Classification der Reptilien, p. 45.

1827.—*Cistuda clausa,* HARLAN, American Herpetology, p. 73.

1830.—*Emys (Cistuda) clausa,* BONAPARTE, Sulla Seconda Edizione del Regno Animale Osservazioni, p. 162.

1831.—*Emys (Cistuda) carolinæ*, GRAY, in Griffith's Animal Kingdom, IX, Append., p. 7.

1831.—*Cistuda carolina*, GRAY, Synopsis Reptilium, I, p. 18.—HOLBROOK, North American Herpetology, 2 ed., I, 1842, p. 31, Pl. II.—DE KAY, Zoology of New York, pt. iii, 1842, p. 24, Pl. I., fig. 1.—GRAY, Catalogue of Tortoises in the British Museum, 1844, p. 30.

1835.—*Cistudo carolina*, DUMÉRIL and BIBRON, Erpétologie Générale, II, 1835, p. 210; IV, 1854, p. 224.—DUMÉRIL, Muséum d'Histoire Naturelle de Paris, Catalogue Méthodique de la Collection des Reptiles, 1851, p. 7 (part).—WIED, Nov. Acta Acad. Leop. Carol., XXXII, i, 1865, p. 1, Pl. I, fig. 1.—GRAY, Supplement to the Catalogue of Shield Reptiles, 1870, p. 19; Hand-list of Specimens of Shield Reptiles in the British Museum, 1873, p. 18.—TRUE, in YARROW, Bull. U. S. Nat. Mus. 24, 1883, p. 37.—BOULENGER, Catalogue of the Chelonians in the British Museum, 1889, p. 115, figs. 32, 33.—STRAUCH, Mém. Acad. Sci. St.-Pétersb. (7) XXXVIII, No. 2, 1890, p. 62 (part).—BAUR, Proc. Amer. Philos. Soc., 1892, p. 44.

1835.—*Pyxidemys schneideri*, FITZINGER, Ann. Wiener Mus., I, p. 123.

1835.—*Pyxidemys virgulata*, FITZINGER, Ann. Wiener Mus., I, p. 123.

1835.—*Pyxidemys clausa*, FITZINGER, Ann. Wiener Mus., I, p. 123.

1857.—*Cistudo virginica*, AGASSIZ, Contributions to the Natural History of the United States, I, p. 445, Pl. IV, figs. 17–19; Pl. VIII, figs. 10–14.

1862.—*Terrapene carinata* (part), STRAUCH, Mém. Acad. Sci. St.-Pétersb. (7) V, No. 7, p. 96; VIII, No. 13, 1865, p. 45.

1875.—*Cistudo clausa*, subsp. *clausa*, COPE, Bull. U. S. Nat. Mus. No. 1, p. 53.

1884.—*Cistudo carinata*, S. GARMAN, Bull. Essex Inst., XVI, p. 10.

1892.—*Cistudo carolina* var. *carolina*, H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 219.

Quadrato-jugal rudimentary, triangular in shape and connected with the quadrate only. Zygomatic arch absent. Maxillary, distinctly beaked but not notched. Cervicals and their processes relatively short. Upper branch of the scapula somewhat longer than the inner branch (endoscapula), but not so long as in *T. major*. Number of phalanges in forefoot, 2–3–3–3–2 or 2–3–3–2–2; hind foot, 2–3–3–3–2. Digits slightly webbed. Claws in the hind foot, 4. First pleural plate approximately twice as long as wide.

Carapace ovoid in outline; ratio of width to length in adults, about as 10 to 12. Not compressed above; keel distinct and median ridge absent. Color dark brown or blackish, marked by yellowish or brownish radiating spots and lines. Often the keel is marked by an interrupted yellow or brownish yellow line.

Plastron oval in outline, with distinct shoulders on each side of the hinge area. Ground color dull yellow, variously blotched and mottled with lavendar brown.

Kentucky and Tennessee specimens are the most beautiful of our North American forms, and may possibly be entitled to rank as a variety of *T. carolina*. The carapace is ovoid in horizontal outline; semiovoid in transverse section. The general color is black or very dark brown, marked by bright yellow, sometimes the latter color prevailing. The posterior portions of the second, third, and fourth vertebral plates are marked by distinct but irregular quadrate blotches which are broadly bordered by bright yellow. The upper portions of the first, second, and third costal plates are similarly marked. The

spaces in front of these blotches on the vertebral plates and below them on the costal plates are marked by spots and radiating blotches of yellow. The presence of a distinct keel and the absence of a median depression are points readily distinguished. The plastron is yellow, irregularly blotched and mottled with much brown and black, broadest across the femorals. The upper portion of the head and neck is brown, slightly specked with yellow; a yellow line beginning at the posterior of the eye runs back over the ear and the posterior of the skull. Mandible, throat, and lower neck light yellow. Upper scales of the legs grayish; lower scales mostly orange or reddish. The individual described is a female collected at Midway, Ky., by Prof. H. Garman. Another specimen very similar but younger was sent me by Prof. S. S. Maxwell. This one was collected at the mouth of Billingtons Creek, near Lovelaceville, Ballard County, Ky., in the extreme western portion of the State, where the writer has often observed other specimens. Prof. Benj. B. Penfield, of Nashville, Tenn., sent me two specimens which agree with the Kentucky individuals in every point except that a distinct triangular quadrato-jugal was present.

In general form and osteological characters this variety grades into, if it is not identical with, typical specimens of *T. carolina*, and may be regarded as the southern extension of this species. Hence the distribution of *T. carolina* may be given as eastern United States, south to Carolinas, Georgia, Tennessee, and Kentucky, reaching the Mississippi, west to eastern Illinois and Wisconsin, and north to Canada.

List of specimens.

No.	Collector.	Collection.	Locality.
1	Dr. G. Baur		Indiana.
2	....do		do.
3	....do		New Haven, Conn.
4	....do		do.
5	L. Stejneger		Washington, D. C.
6	J. D. Figgins	No. 20544, U. S. N. M.	Kensington, Md.
7	Prof. S. S. Maxwell		Lovelaceville, Ky.
8	Prof. H. Garman		Midway, Ky.
9	Dr. O. P. Hay		Kentucky.
10	Prof. B. B. Penfield		Nashville, Tenn.
11	....do		do.
12	P. S. Young	No. 11600, U. S. N. M.	Rock Creek, D. C.
13	Frank Burns	No. 14624, U. S. N. M.	Darlington, S. C.
14	J. D. Ridgway	No. 14670, U. S. N. M.	Wheatland, Ind.
15	....do	No. 14670, U. S. N. M.	do.
16		No. 8539 (?)	Carlisle, Pa.
17	B. A. Bean	No. 13588, U. S. N. M.	Bainbridge, Pa.
18	Dr. G. Baur		Albany, N. Y.
19	....do		do.

TERRAPENE MEXICANA (Gray).

1849.—*Onychotria mexicana*, GRAY, Proc. Zool. Soc. London, 1849, p. 17, Pl. II (type in British Museum; locality of type, Mexico).—DUGÈS, La Naturaleza (2), 1888, p. 11.

1855.—*Cistudo mexicana*, GRAY, Catalogue of Shield Reptiles in the British Museum, p. 40; Supplement to the Catalogue of Shield Reptiles, 1870, p. 19.—BOCOURT, Mission Scientifique au Mexique, Reptiles, fasc. 1, 1870, p. 17 (part).—GÜNTHER, Biologia Centrali-Americana, Reptilia, 1885, p. 1.—COPE, Bull. U. S. Nat. Mus. 32, 1887, p. 21.

1889.—*Cistudo carolina* var. *mexicana*, BOULENGER, Catalogue of Chelonians in the British Museum, p. 118.

1891.—*Terrapene mexicana*, BAUR., Science, XVII, 1891, p. 191; Amer. Natural , 1893, p. 677.

Quadrato-jugal very rudimentary; connected with the quadrate and rather elongated. Zygomatic arch absent. Upper branch of the scapula as in *T. major*. No webs between the digits and only three claws on the hind foot. Number of phalanges in the forefoot 2–3–3–2–2; in hind foot 2–3–3–3–1. Maxilla not notched.

Carapace oval in horizontal outline; rather triangular in transverse outline. Ratio of width to length in adults approximately 10 to 13. The additional plate found between the fourth and fifth vertebral plates seems to be characteristic. First pleural plate more than three times as long as wide.

Color of the carapace brownish yellow marked by dark brown radiating lines and irregular spots. Head yellow, irregularly marked by black or dark brown. Throat yellow, posterior neck light brown.

Plastron curved in the region of the abdominal and femoral plates, and distinctly mucronate posteriorly. Color, whitish yellow, the posterior border of each dermal plate bordered with smoky brown.

City of Mexico and Tampico, Mexico.

List of specimens.

No.	Collector.	Collection.	Locality.
1	Dr. Herrera.......	Dr. G. Baur......................	Mexico.

TERRAPENE TRIUNGUIS (Agassiz).

1831.—? *Emys kinosternoides*, GRAY, in Griffith's Animal Kingdom, IX, Append., p. 12; Synopsis Reptilium, 1831, p. 32.

1835.—*Emys cinosternoides*, DUMÉRIL et BIBRON, Erpétologie Général, II, p. 303; IX, 1854, p. 227. DUMÉRIL Muséum d'Histoire Naturelle, Catalogue Méthodique de la Collection des Reptiles, 1851, p. 12.

1844.—*Emys* (*Emyoides*) *kinosternoides*, GRAY, Catalogue of Tortoises in the British Museum, p. 27.

1857.—*Cistudo triunguis*, AGASSIZ, Contributions to the Natural History of the United States, I, p. 445, Pl. VII (type in Mus. Comp. Zool., Cambridge, Mass.; locality of type, Louisiana).—GARMAN, Bull. Essex Inst., XVI, 1884, p. 10.

1865.—*Terrapene carinata* (part), STRAUCH, Mém. Acad. Sci. St. Petersb., (7) VIII, No. 13, p. 45.

1875.—*Cistudo clausa* subsp. *triunguis*, COPE, Bull. U. S. Nat. Mus., 1, p. 53.

1883.—*Cistudo carolina triunguis*, TRUE in Yarrow, Bull. U. S. Nat. Mus. 24, p. 37.

1889.—*Cistudo carolina* var. *cinosternoides*, BOULENGEP, Catalogue of Chelonians in the British Museum, p. 117.

1890.—*Cistudo carolina* (part), STRAUCH, Mém. Acad. Sci., St. Petersb., (7) XXXVIII, 2, p. 62.

1891.—*Terrapene cinosternoides*, BAUR, Science, XVII, 1891, p. 191.

1893.—*Terrapene triunguis*, BAUR, Amer. Natural., 1893, p. 677.

Quadrato-jugal rudimentary and triangular; connected with the quadrate only. Zygomatic arch absent. Scapula as in *T. major*. No webs between the digits, and only three claws on the hind foot. Phalanges in the forefoot, 2–3–3–2–2; hind foot, 2–3–3–2–1. Maxillæ slightly notched. Cervicals and their processes relatively short.

Carapace moderately oval, keeled, and slightly compressed. Ratio of width of carapace to length in adults about 10 to 13. First pleural plate similar to *T. bauri*. Ground color dark-brown or olive-yellow, much mottled with yellow.

Plastron oval. Ground color yellow, much mottled with brown.

The Louisiana form seems to be a dwarf variety of this species and is peculiar to Louisiana. They were first noticed by Agassiz who states: "Had I not noticed a few larger specimens from the Osage River and from Georgia, I should not hesitate to consider them as a distinct species." They are characterized by their relatively small size, peculiar markings, and rather full development of the quadrato-jugal. Some times the quadrato-jugal is sufficiently developed to come into contact, if not uniting, with the jugal. These individuals are readily distinguished by their small size, three toes, and general color. In color they vary from pale yellow or dusky to dark brown, marked by small radially distributed yellow spots, often only few in number. The fact that they grade into larger forms of other localities prevents them from being ranked as a separate species.

Mississippi, Louisiana, Arkansas, Indian Territory, southern Missouri and Kansas, and Texas.

List of specimens.

No.	Collector.	Collection.	Locality.
1	G. Kohn		New Orleans, La.
2	....do		do.
3	....do		do.
4	....do		Mandeville, La.
5	....do		do.
6	....do		do.
7	Dr. O. P. Hay		Shubuta, Miss.
8	Julius Hurter		St. Louis, Mo.
9	....do		do.
10	Dr. Kennerly	No. 53, U. S. N. M.	Fort Inge to San Antonio, Tex.
11		No. 7345, U. S. N. M.	Wailes, Miss.
12		No. 303 (7174), Mus. Phila. Acad. Sci.	Mill Creek, Chickasaw Nation, Ind. T.
13		No. 304 (7177), Mus. Phila. Acad. Sci.	Fort Arbuckle, Ind. T.
14	Dr. E. Palmer	No. 305 (7192), Mus. Phila. Acad. Sci.	Fort Gibson, Ind. T.

TERRAPENE ORNATA (Agassiz).

1857.—*Cistudo ornata*, AGASSIZ, Contributions to the Natural History of the United States, I, p. 445, Pl. III, figs. 12, 13 (type in Mus. Comp. Zool., Cambridge, Mass.; locality of type, Upper Missouri, Iowa).—COPE, Bull. U. S. Nat. Mus. 1, 1875, p. 53; Bull. U. S. Nat. Mus. 17, 1880, p. 13.—TRUE in Yarrow, Bull. U. S. Nat. Mus. 24, 1883, p. 37.—GARMAN, Bull. Essex Inst., XVI, 1884, p. 10.—BOULENGER, Catalogue of Chelonians in the British Museum, 1889, p. 118.—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, 1892, p. 220.

1891.—*Terrapene ornata*, BAUR, Science, XVII, 1891, p. 191; Amer. Natural., 1893, p. 678.

Quadrato-jugal entirely absent, and hence zygomatic arch never present. Postorbital arch much more slender than in other species. Maxillæ notched. Cervicals and their processes relatively very short. Upper branch of the scapula of the same length as the inner branch (endoscapula). Digits without distinct webs. Number of phalanges in forelimb, 2–2–2–2–2; hind limb, 2–3–3–3–1. Number of claws in the hind foot, 4.

Carapace in horizontal outline broadly oval; much compressed above; medium ridge usually present, but the keel always absent, even in the young. Interpleural foraminæ between the ribs of the first and second dorsal vertebræ almost obsolete. Ratio of the width to the length of the carapace in adults, never exceeding ten to twelve, rarely more than ten to eleven. The depression of the carapace is usually so great as to render the outline of a transverse section almost oblong in shape.

The ground color of the carapace varies from very dark-brown, marked with bright-yellow radiating lines with a yellow medium line, to very light colors with no markings. Third vertebral plate less than two-thirds as long as wide, being in all other species relatively longer.

Plastron widest across the abdominal plates. Ground color brown, marked by irregular yellow lines. Posterior to the hinge ligament these lines show a tendency to become longitudinal, while on the anterior of the hinge ligament these lines are mostly transverse.

East of the Rocky Mountains to Wisconsin, eastern Illinois, central Indian Territory, and eastern Texas.

List of specimens.

No.	Collector.	Collection.	Locality.
1	Dr. G. Baur		Lawrence, Kans.
2	......do		Indiana (?).
3	......do		Kansas; Logan County.
4	......do		do.
5	Dr. O. P. Hay		do.
6	......do		Kansas.
7	Prof. T. D. A. Cockerell		Las Cruces, N. Mex.
8	Roy R. Larkin		do.
9	Prof. J. D. Bruner		El Paso, Tex.
10	William Lloyd	No. 16484, U. S. N. M	South of Devil's River, Texas.
11	......do	No. 20959, U. S. N. M	Corpus Christi, Tex.
12	Dr. Kennerly	No. 52, U. S. N. M	San Antonio to Fort Inge, Tex.
13	Prof. H. B. Duncanson		Peru, Nebr.
14	Hayden	No. 7541, U. S. N. M	Sand Hills, Nebraska.
15	Kennicott	No. 7542, U. S. N. M	Illinois.
16	Hayden	No. 57, U. S. N. M	Yellowstone (River).
17	......do	......do	do.
18	Bailey	No. 15861, U. S. N. M	Kennedy, Nebr.
19	Julius Hurter	No. 16491, U. S. N. M	St. Louis, Mo.
20	Palmer	No. 7177, U. S. N. M	Old Fort Cobb, Okla.
21	W. S. Wood	No. 156, U. S. N. M	Republican River, Nebraska.
22	......do	No. 156, U. S. N. M	do.
23	Dr. Hayden	U. S. N. M	Fort Laramie, Wyo.
24	Dr. Meyer		Kankakee, Ill.

GENERAL REMARKS.

The geographical distribution of *Terrapene* offers many interesting phases for study. The relatively fixed habits of the species of the genus render their variations more or less local in character. Good illustra-

tions of this fact are seen in the *T. ornata* of Texas and the *T. triunguis* of Louisiana and southwestern Arkansas and southeastern Indian Territory. But, notwithstanding these conditions, the specific characters are maintained throughout the range of each species, as has been shown.

Terrapene major may be said to be strictly a gulf species, having for its range the gulf coast from the Rio Grande to Florida, possibly including southern Georgia. The specimens examined by me seem to be larger in the average than individuals of other species, and in general osteological characters they certainly represent the primitive form of the genus. They possess a well-developed quadratojugal, a complete zygomatic arch, and are distinguished from *T. bauri* by the number of phalanges, color pattern, and webbed digits, there being four claws on each hind foot.

Terrapene bauri may be said to belong to the peninsula of Florida, possibly including southern Georgia. It resembles *T. major* in having a complete bony zygomatic arch and *T. triunguis* in having but three toes on the hind foot, while it differs from either in the number of its phalanges. The color markings of the type, excepting plastron, are almost identical with *T. ornata*, a species from which *T. bauri* is completely separated both by osteological characters and geographically. The specimens mentioned by Agassiz as three-toed specimens of *T. carolina* from North Carolina, and *T. triunguis* from Georgia may belong to this species.

Terrapene carolina is found in the northeastern United States, extending from the St. Lawrence and Great Lakes south to the Carolinas and Tennessee and west to the Mississippi River in Kentucky and to eastern Illinois.* This species seems to exist in greatest abundance in New Jersey and adjacent regions, but Dr. Hinds informs me that it is very common at Lebanon, Tenn. It seems to be, in a certain sense, the mountain species, being found thoughout the mountains of Pennsylvania, as well as elsewhere, and seems to be coextensive with the Allegany range southward. It is characterized by its rudimentary quadrato-jugal, the hooked upper jaw, and the presence of a distinct keel on the carapace, the number of phalanges, and its slightly webbed digits.

* Unfortunately I am unable to speak definitely as to the precise western limit of *T. carolina* north of the Ohio River. The specimens reported by Prof. H. Garman as from various points in southwestern Illinois are inaccessible at the time of writing, owing to alterations now being made in the museum at Champaign, Ill. Prof. W. K. Higley, in his catalogue of Wisconsin reptiles, mentions *T. carolina* as collected at the following places in Wisconsin, namely, Walmouth County, two specimens; Milwaukee; Pine Lake; La Crosse; and Green Bay. Not having had an opportunity to examine Prof. Higley's specimens, I have been unable to verify his identifications. Mr. Hurter, in his catalogue of St. Louis reptiles, mentions one specimen of *T. carolina,* but since it is the only one which has been found in that locality he rather infers that it was brought into St. Louis. This inference is made more probable by the fact that the individual was found in the elevator yards.

On the south it adjoins or overlaps the territory of *T. bauri* and *T. triunguis*, while on the west it overlaps the *T. triunguis* and *T. ornata* for a comparatively short distance. Its principal characters remain constant whether the specimens be taken from the Atlantic coast, the mountains of Pennsylvania and Tennessee, or the prairies of Ohio and Indiana. Specimens from Kentucky and Tennessee exhibit certain peculiarities in color markings. These peculiarities have been discussed fully under the specific characters of *T. carolina*.

Terrapene mexicana is at once distinguished by its tectiform carapace, rudimentary quadrato-jugal, and the number of phalanges. Several authors have reported this species from the City of Mexico, and Bocourt mentions one specimen as from Tampico, Mexico—the most northerly locality reported. These meager data would hardly justify me in outlining its range.

Terrapene triunguis in many respects shows a peculiar distribution. Roughly speaking it may be said to occupy the swampy districts of the Lower Mississippi and bordering territory. It is found in the southern half of the State of Mississippi, and passing into the extreme southwestern portion of Illinois is found as far north as St. Louis, Mo.; thence west in the Osage River Valley in eastern Kansas; thence southwest to the Arkansas River and its tributaries in Indian Territory; thence to Matagorda Bay bordering the gulf from the Rio Grande to Alabama. This species is characterized by its rudimentary triangular quadrato-jugal, its number of phalanges and webless digits, three claws on the hind foot, its keeled carapace with its slight median depression.

Both Dr. Baur and O. P. Hay inform me that in southwestern Arkansas and central and eastern Indian Territory specimens are often found which are greenish yellow and without spots, but marked individuals are also present in the same region. Specimens from Louisiana are rather small, having a dwarfed appearance, and are somewhat peculiar in their markings. Their osteological characters, also, are somewhat variable. However, typical specimens of the species are found in this region.

Terrapene ornata is found from the Rocky Mountains east to Lake Michigan and Indiana, south to the Ozark Mountains, and east to western Indian Territory and central Texas, and from the Rio Grande River north to the Yellowstone River. This species may be said to belong to the plains and the table-lands. In Kansas, where it becomes extremely numerous, Prof. Cragin speaks of it as so abundant as to become a nuisance as a cumberer of the ground. It seems to subsist and thrive in our most arid climates, being found in the sand hills of Nebraska and the barren regions of New Mexico and Texas. In its geographical distribution it seems to be governed more by soil, rainfall, and vegetation than latitude. Throughout all its range it is characterized by the entire absence of the quadrato-jugal, the possession of only two phalanges in each digit in the forefoot, its broadly oval carapace, with a median ridge but without keel, a plastron widest across the abdominal

plates, and the variegated markings of the carapace. Texas specimens are somewhat stouter and more compact, and often individuals possessing no color markings are found, but, notwithstanding these exceptions, the species is remarkably constant throughout its range. It occupies a larger territory than all other species combined.

In the taxonomy of *Terrapene*, as first noted by Dr. Baur, the modification of the zygomatic arch occupies an important position. The quadrato-jugal is well developed in primitive forms of the genus, rudimentary in intermediate forms, and absent in *T. ornata*, the most specialized species.

Fig. 1.

SKULL OF CYCLEMMYS AMBOINENSIS.

a.—Postfrontal. *b.*—Quadrato-jugal. *c.*—Jugal.

The skull of a species belonging to a closely related genus, *Cyclemmys amboinensis*, is represented in fig. 1. In this species the elongated quadrato-jugal (*b*) lies along the anterior border of the quadrate completely separating the latter, as well as the squamosal, from the jugal (*c*) and postfrontal (*a*). The postfrontal is much elongated and widened, and with the jugal and quadrato-jugal forms a complete zygomatic arch.

Fig. 2 shows the zygomatic arch of *T. major*. The postfrontal has retreated and in this species forms a narrow club-shaped bone just posterior to the orbit and takes no part in the formation of the zygomatic arch. However, a complete arch is present, composed of the somewhat quadrangular quadrato-jugal and the jugal.

Fig. 3 illustrates the structure of the zygomatic arch of *T. bauri*, a form, in this respect, closely related to *T. major*. It will be noticed that this arch is more slender than in *T. major*.

In *T. carolina* (fig. 4) the quadrato-jugal is rudimentary and is not connected with the jugal, and hence the bony zygomatic arch is incomplete.

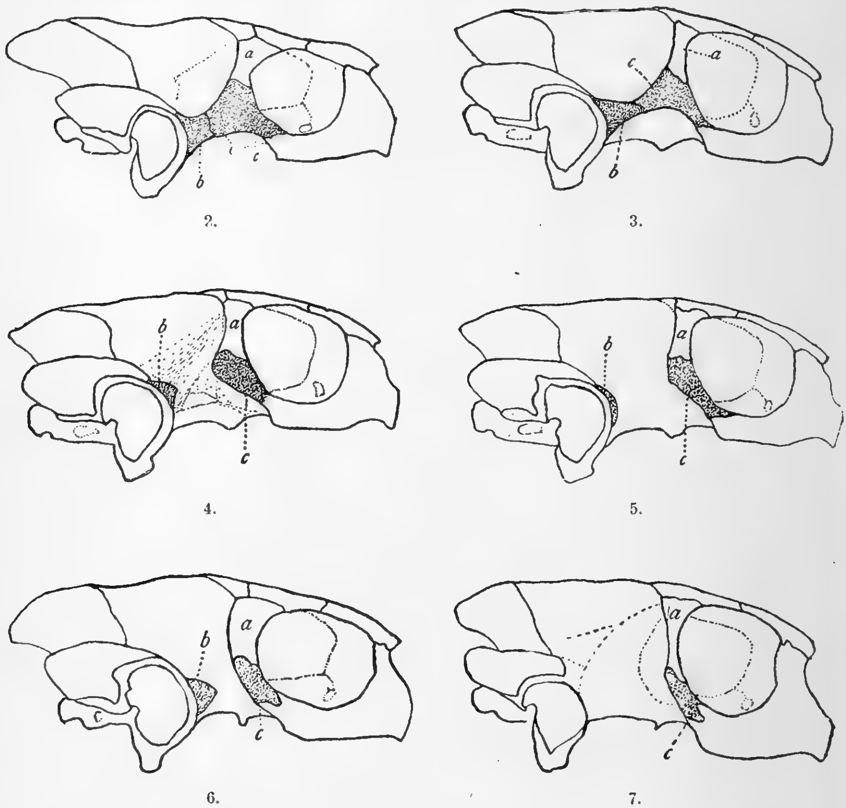
In *T. mexicana* (fig. 5) the zygomatic arch is incomplete, and the quadrato jugal has been reduced to a very small remnant. The same thing may be said of *T. triunguis* (fig. 6), except that in this species the quadrato-jugal is more nearly triangular. In *T. ornata* (fig. 7) the zygomatic arch has completely disappeared.

In this connection the modification of the phalanges seems worthy of our attention. In all species there are five digits in each foot, and on the fore foot of each there are five well-developed claws. However, in the fore foot the number of phalanges varies, the number being in *T. major*, *T. bauri*, and usually *T. carolina*, 2–3–3–3–2; in *T. mexicana*, *T. triunguis*, and sometimes *T. carolina*, 2–3–3–2–2, and in *T. ornata*, 2–2–2–2–2.

The hind foot of *T. major*, *T. carolina*, and *T. ornata* possesses four claws, while in the remaining species but three claws are present. With

reference to the number of phalanges in each hind foot the species are as follows: *T. major* and *T. carolina*, 2–3–3–3–2, the same number as in the fore foot; *T. ornata* and *T. mexicana*, 2–3–3–3–1; *T. bauri* and *T. triunguis*, 2–3–3–2–1.

The loss of the phalanges on the hind foot might be accounted for by supposing that the distal phalange does not develop. But in the case of the fore foot, where the full number of claws are still present, the distal phalange evidently does not disappear. Hence the reduction



Figs. 2–7.

SKULLS OF TERRAPENE.

Showing modification of the zygomatic arch in different species.

a, Postfrontal. *b*, Quadrato-jugal. *c*, Jugal.

(For explanation of figures see page 585.)

must take place either by the coossification of two phalanges, or a phalange and a metacarpal, or by the disappearance of a phalange.

Zehntner, 1890, after studying the development of the Alpine Swift, *Cypselus melba*, concludes that the reduction in the number of phalanges takes place in this species by coossification. He states that in the fourth digit the first phalange probably unites with the fourth metatarsal, while the third and fourth phalanges unite with each other.

Also the second and third phalanges of the third digit unite. Hence in the *Cypselus*, notwithstanding that in the early stages of growth the normal number of phalanges for birds, 2–3–4–5, is developed, in this genus the number of phalanges in adults is 2–3–3–3.

Pfitzner, 1890, discusses the reduction of the number of phalanges in the little toe of man. In embryos and young children he found the normal number of phalanges 3, but in the case of older children the middle and the end phalanges usually unite, though in some instances the middle phalange disappeared.

In *Terrapene* I have not been able to determine the method of the reduction in the number of phalanges since embryological material of *T. ornata* has not been obtained. I hope to be able to investigate this question further at a later date. But, in the examination of younger specimens, I find no evidences of coossification such as would probably be indicated by the disproportionate length of a phalange formed by the union of two phalanges.

The distribution of the species of *Terrapene* presents several interesting problems. It seems probable that all of our species are derived from one form. The closeness of the relations of the species would seem to indicate that our forms are varieties rather than species. However, at least two difficulties are in the way of this conclusion. First, there can be no question but that if we take two extremes of development of the species of the genus, for instance, *T. major* and *T. ornata* or *T. carolina* and *T. ornata*, we must recognize them as separate species. But since other intermediate forms seemingly connect these species, if the closeness of relations be considered as indicating varietal characteristics only, we are forced to consider all species as varieties, a conclusion that would seem to be erroneous. Second, while the relations indicated by a study of the different species seems close, yet the distinctions seem definite and fixed, even where the ranges of the species overlap. The study of a number of specimens seems to indicate that the different species are derived from one form, and that afterwards, by isolation, caused possibly by geological and climatic agencies, they became distinct. When we remember the comparatively fixed abode of these animals it seems reasonable to suppose that these changes might have been brought about by relatively simple agencies which need not necessarily have acted simultaneously. Hence, it would seem proper to classify each form as a distinct species, each possessing certain fixed osteological characters. If these conclusions be true then it would seem most reasonable to suppose that *T. ornata* has become more distinct from the other species by its comparatively longer isolation, aided by the generally arid climate of its habitat.

It will at once be noticed that of the species found within the United States each occurs in a district which, in certain geographical features, is peculiar to itself. *T. ornata* occupies a district peculiar in its arid climate and, for the most part, sandy soil. *T. triunguis* is found in the

low swampy regions of the Mississippi and its tributaries, the climatic conditions here being the reverse of the district occupied by *T. ornata*. *T. carolina* occurs in both the mountains and plains, yet its climatic surroundings are somewhat uniform and peculiar to its region. *T. bauri* inhabits the peninsula of Florida, while *T. major* is found adjacent to the gulf coast, the two species occupying districts each peculiar in itself.

Another peculiar fact in the distribution of *Terrapene* is that, so far not a single species has been reported west of the Rocky Mountains, notwithstanding its great abundance on the table-lands east of these mountains.

For an explanation of the cause of this fact we can only surmise. It is well known that in the Alleghany Mountains *T. carolina* ascends to a height of several thousand feet, as high, probably, as any other species of our chelonians. Prof. Cockerell and Mr. Ray R. Larkin have sent us specimens of *T. ornata*, collected at Las Cruces, N. Mexico, between five and six thousand feet above the sea level. Possibly the true explanation of the fact that *Terrapene* has not been found west of the Rockies may be accounted for by the great elevation and consequent climate of the mountains. If this explanation be the true one, then it is only a question of time when the *Terrapene* will finds its way over the Rocky Mountain range.

The information extant and the material at our command, we regret to say, does not permit us to accurately outline the limits of the species either south or north of the United States boundary lines. It seems probable that at least one or more of our species may extend into Mexico, though no such record exists. Neither do we have any authentic record of the existence of the *Terrapene* in British America, though it is possible, if not probable that specimens will ultimately be found there. However, if we judge from the comparatively small number of specimens found on the northern borders of the United States, the species can not be abundant north of the boundary line.

UNIVERSITY OF CHICAGO,
Chicago, Illinois, June 1, 1894.

DESCRIPTION OF UTA MEARNSI, A NEW LIZARD FROM CALIFORNIA.

By Leonhard Stejneger,

Curator of the Department of Reptiles and Batrachians

The accidental nature of reptile collecting is well illustrated by the discovery of this very conspicuous and distinct species in a region which has been visited before by some of our best collectors.

The trenchant character of the distinctions between the present species and its nearest ally inhabiting the Cape St. Lucas region emphasizes the gap between the Cape region proper and the rest of the Lower California peninsula.

This discovery, moreover, is quite important, inasmuch as it bridges over the supposed difference between *Uta thalassina* and the other species of the genus *Uta*. Boulenger, in 1885,* established the genus *Petrosaurus* for that species because of its small caudal scales, the smoothness of the dorsal granules, and the absence of denticulation on the border of the posterior gular fold. The present species, however, has the caudal scales large, keeled, and spinose, in fact, exactly as in the typical species of the genus *Uta;* the dorsal scales are larger, more convex, nearly tubercular on the sides, thus approaching the other Utas, while the question of denticulation to the collar is one essentially of degree only. However, the species which I am dedicating to its discoverer, Dr. E. A. Mearns, U. S. A., naturalist of the International Boundary Commission (United States and Mexico), is undoubtedly nearly related to *U. thalassina* and more so than to any of the other species of the genus.

UTA MEARNSI, new species.

Diagnosis.—Dorsal scales uniform, small, smooth; edge of gular fold without enlarged scales; four or five very long and pointed scales on anterior border of ear-opening; tail with large, strongly keeled, spinose scales; scales on arms and legs strongly keeled. One well-marked

* Catalogue of the Lizards in the British Museum, II, p. 205.

[Advance sheets of this paper were published November 30, 1894.]

black line from shoulder to shoulder across the back; tail above, regularly cross-barred with black.

Habitat.—East slope of Coast Range on boundary line between California and Lower California.

Type.—No. 21882, U. S. N. M., Summit of Coast Range, United States and Mexican boundary line, California.

Description of the type.—Female. Head moderately depressed, snout narrow; canthus rostralis well marked; nostrils rather large, almost superior, much nearer to the tip of the snout than to the orbit; ear-opening large, with four very long, triangular, pointed scales and three smaller ones in front; head-shields smooth; frontal divided transversely; about eight of the posterior supraorbital scales enlarged, one being particularly large, these separated from the frontals by a single series of granules; superciliaries, particularly the anterior ones, very long and narrow; a very long and narrow infraorbital; occipital as large as ear-opening; supralabials six, and, like rostral, very wide and low; infralabials scarcely higher, but considerably narrower; scales on throat small, rounded, smooth, those on the middle and near the edge of the gular fold somewhat larger; only one transverse gular fold, not denticulated; sides of neck strongly folded; scales on back and sides rather large, rounded and convex granules, those on lower surface of body larger, flat, hexagonal; limbs with enlarged, keeled scales, and rather long, the anterior when pressed to the side reaching to the insertion of the thigh, the posterior when stretched forward reaching to the orbit; twenty femoral pores on each side; tail depressed at base, slender, its length more than one and three-fourths that of head and body, covered with rings of rather large scales which, on the upper surface and the sides, are provided with a very strong keel ending in a projecting spine.

Color above olive, more brownish on head and tail, with irregular dusky, nearly blackish, cross-bands; lighter spots, or marblings, on the interspaces; a very distinctly marked, straight, and intensely black band from shoulder to shoulder across the back; limbs irregularly cross-banded with dusky; basal two-thirds of tail pale brownish olive with wide black cross-bars, terminal third uniformly blackish; under surface greenish white, bluish on flanks with lighter dots; chin and throat with a network of bluish gray.

Dimensions.—Total length, 229 mm.; head and body, 79 mm.; tail, 150 mm.; fore limb, 37 mm.; hind limb, 61 mm.

Variation.—In addition to the type Dr. Mearns' collection contains six other specimens which fully establish the characters of the species. The individual variation is comparatively slight, and but few deviations from the above description of the type are noticed. In some specimens there seems to be a slight anterior gular fold, but it is not marked by any difference in the scutellation. In one specimen the frontal is not divided transversely, and in about one-half, the large supraoculars are

separated from the frontal by a double row of granules. Other discrepancies will be noticed in the list of specimens given below.

The males have enlarged postanal scales.

The individual differences of coloration consist mainly in the outline and intensity of the dusky cross-bars, while the black collar is equally distinct in all.

The sexes are alike in color, except thatt he blue flank-patch is somewhat darker and wider in the males.

Comparison with Uta thalassina.—Although closely allied to *Uta thalassina*, described in 1863 by Prof. Cope from specimens collected at Cape St. Lucas, the present species differs in many essential points, most of which have been indicated in the diagnosis.

In addition to these it may be remarked that the granules on the back are larger in *Uta mearnsi*, but that the ventral scales are smaller; it lacks the well-defined anterior gular fold of *U. thalassina;* the legs and tail are comparatively longer, and the femoral pores are more numerous; each of the latter, moreover, is bordered behind by two granules, while in *U. thalassina* there are three. The last mentioned species appears also to be much the larger, as the specimens collected by Dr. Mearns seem to be quite adult.

The most striking differences, however, are the long preauricular spines and the large, strongly keeled, and spinous caudal scales of *Uta mearnsi*, together with the absence of the two posterior dorsal black bands so characteristic of *U. thalassina*.

Geographical distribution.—Dr. Mearns found this species "extremely plentiful" among the rocks on the eastern slope of the Coast Range of California, near the Mexican boundary line, from the lowest water in the canyon at the base to the summit. So far this is the only locality where it is known to have been taken. I would suggest, however, that it was most probably this species which Mr. Lockington has recorded from Ensenada, Todos Santos Bay, Lower California, 75 miles southeast of San Diego (*Amer. Natural.*, 1880, p. 295), as *Uta thalassina*.

List of specimens.

Catalogue number U.S.N.M.	Sex.	Locality: Coast Range, California, near the Mexican boundary.	Body and head.	Tail.	Femoral pores.	Supralabials.
			mm.	*mm.*		
21882	Female	Summit of range	79	150	20	6
21883	Female	Mountain Spring, eastern slope	74	(*)	22	5-6
21884	Female	Eastern base	78	(*)	20	5
21885	Female	do	75	140	21-22	5
21886	Male	Mountain Spring, eastern slope	79	(*)	23-25	5-6
21887	Male	do	88	(*)	21-24	6
21888	Female	Lowest water, eastern base	73	(*)	19-20	6

* Tail reproduced.

NOTES ON BUTLER'S GARTER SNAKE.

By Leonhard Stejneger,

Curator of the Department of Reptiles and Batrachians.

The garter snakes of North America constitute one of the most difficult groups with which the ophiologist has to deal. The geographical variation is recognized to be excessive, while at the same time the individual variation is so great as to obscure the boundaries between the species. The result is that there is a great diversity of opinion among authors as to the number of species and the proper limitation of the forms, and while one is inclined to recognize a long series of species, another will only allow a very limited number indeed, though admitting numerous "varieties," at least of some of the species.

While undoubtedly many a slight variety, or even individual freak, has been designated as a species, on the other hand, some of the most distinct species have suffered degradation to mere varieties or subspecies.

The *Thamnophis butleri* of Cope is an example of this. In 1889 Prof. Cope described a single specimen from Richmond, Ind., under the above name, dedicating it to Amos W. Butler. In describing it he stated expressly that "it is remarkably distinct from everything which occurs in the United States, and has only a superficial resemblance to the *E. flavilabris*, Cope, of Mexico." This statement alone should have prevented it from ever becoming associated with *Thamnophis sirtalis* as a subspecies until additional material should establish the incorrectness of Prof. Cope's standpoint, who, having himself endeavored to subordinate the various binominals under other forms as trinominals, would have been able to discover the relationship with *T. sirtalis*, if such relationship existed. But no such additional material has been forthcoming.

It is therefore with great satisfaction that I announce that a second specimen has recently been obtained and added to the collection of the National Museum. It was collected by Mr. P. H. Kirsch, of the U. S. Fish Commission, at Cedar Creek, Waterloo, Ind., on July 17, 1893. This specimen, No. 21692 U.S.N.M., corroborates everything Prof. Cope said about the species in the original description and sub-

stantiates the characters relied upon for its separation. The number and size of the temporals (1+1) is the same, and the lateral stripe involves distinctly the second, third, and fourth scale rows. The size and shape of the head is also quite characteristic, it being remarkably small and conical. Moreover, the eye is proportionately much smaller than in any of our *Thamnophis* species, with the exception of *T. leptocephalus* and *T. vagrans.*

This smallness of the eye is so striking, and it reminds one so much of the last-mentioned species, that I have a strong suspicion that the specimen which E. W. Nelson collected near Chicago, Ill., in 1874, and identified with *T. vagrans*,* was, in reality, a third specimen of the rare *T. butleri*, about the geographical range of which we can at present only guess. It is almost needless to add that *T. vagrans* does not occur in Illinois.

For the sake of completeness I add the synonymy of the species which is the subject of the present article.

1889.—*Eutænia butleri*, COPE, Proc. U. S. Nat. Mus., XI, 1888, p. 399.

1892.—*Eutænia butlerii*, COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 651.—*Eutainia butlerii*, HAY, Batr. Rept. Indiana, p. 120 (1892).

1893.—*Tropidonotus ordinatus* var. *butleri*, BOULENGER, Cat. Snakes Brit. Mus., I, p. 212.

* See Davis and Rice, Bull. Chicago Acad. Sci., I, iii, 1883, p. 30.

ON THE SPECIFIC NAME OF THE COACHWHIP SNAKE.

By Leonhard Stejneger,

Curator of the Department of Reptiles and Batrachians.

The name commonly applied to this species is *Bascanion flagelliforme*, and as authority for this name Catesby's Natural History of Carolina has been as frequently quoted. Catesby's names antedating Linnæus' tenth edition and, besides, not being binominal have no standing in zoological nomenclature. One subsequent to 1758 has therefore to be adopted.

Curiously enough no one seems to have supplied a true binominal name for this snake until after the beginning of the present century, the first being apparently Shaw's *Coluber flagellum*,* which is based exclusively on Catesby's, Vol. II, plate LIV, consequently the species in question, without the slightest doubt. I think it will also be found that no one applied *Coluber flagelliformis* binominally to the present species until Holbrook, in the first edition of his Herpetology (1836), adapted it from Catesby's *Anguis flagelliformis*.

The erroneous application of the specific name *flagelliformis* to our coachwhip snake is due to a misidentification of Laurenti's *Natrix flagelliformis*.† That he describes an entirely different snake will be plain from a glance at his diagnosis, which is based on "Seba II. 23, 2" as follows: "Supra cæruleo æquali, infra viridescente; capite angulato; rostro producto tetraedro; dorso utrinque linea alba ab abdomine distincto; cauda pentaedra."‡ He then adds: "var β. (Catesby Carolin. 2.47);" but Catesby's plate XLVII is not our coachwhip, being distinguished from Laurenti's diagnosis chiefly, as he says: "Colore magis cæruleo viridescente."§

It will be seen that Laurenti's snake is not the coachwhip snake, neither in its entirety nor in part.

* Shaw, Gen. Zool., III, pt. ii, p. 475 (1802).

† Synopsis Reptilium, 1768, p. 79.

‡ Above uniform blue, below greenish; head angular; snout produced, tetrahedral; back separated on either side from belly by a white line; tail pentahedral.

§ By the more greenish blue color.

The next quotation often referred to our snake is Daudin's *Coluber flagelliformis*,* but with no better reason, as it is a snake "supra læte viridis, subtus albidus,"† which Daudin confounds with another of Catesby's green species, viz, pl. LVII. This is, however, the *Coluber æstivus* of Linnæus. As a matter of fact, Daudin refers Catesby's representation of the true coachwhip snake, viz, "*Anguis flagelliformis*, Catesby, Hist. nat. Carol. pl. 54," to his *Coluber filiformis* which consequently becomes in part a synonym of *Bascanion flagellum*.

* Hist. Nat. Rept., VI, 1803, p. 380.
† Above light green, below whitish.

DESCRIPTION OF A NEW SALAMANDER FROM ARKANSAS WITH NOTES ON AMBYSTOMA ANNULATUM.

By Leonhard Stejneger,
Curator of the Department of Reptiles and Batrachians.

Among some specimens recently received from Hot Springs, Ark., through Messrs. H. H. and C. S. Brimley, there are two species of salamanders which are interesting in the highest degree, as one represents a new species of *Desmognathus*, while the other is the second specimen of *Ambystoma annulatum*, the first one which with certainty establishes this species as North American, as the locality of the type and hitherto unique specimen is unknown.

DESMOGNATHUS BRIMLEYORUM, new species.

Diagnosis.—Mandibular alveolar margin continuous and completely toothed; tail compressed, keeled, finned; a tubercle in canthus oculi; 14 costal folds; gular fold absent, or very faint; parasphenoid patches not separated anteriorly; vomerine series, when present, long and oblique; underside pale with faint dusky mottling, if any.

Habitat.—Hot Springs, Ark.

Type.—U. S. National Museum No. 22157.

Description.—Head rather large; body long and slender; tail shorter than head and body; limbs short, when adpressed not meeting by four or four and a half costal interspaces; digits short, variable in proportion, but outer finger usually considerably reduced.

Costal grooves, including the axillary and inguinal, 14; gular fold absent, or but feebly indicated; a vertical groove behind the angle of the mouth, and another a little distance in front of fore limb, the former connected with the posterior angle of the eye, all very faint; a well-marked papilla in the angle of the eye; a vertical groove from nostril to edge of lip.

Maxillary and mandibular teeth small, numerous, and continuous almost to the angle of the mouth, all very blunt, except those on the premaxillaries, which are sharp and pointed; vomerine teeth, when present, in two long series posteriorly nearly parallel but diverging anteriorly outward toward the choanæ, from which they are separated

by about the same distance as from the parasphenoid patches; the latter are quite continuous anteriorly, diverging backwardly, consequently forming one apparently heart-shaped patch.

Outline of lower mandible, seen from below, rounded, with no anterior narrowed prolongation.

Tail nearly cylindrical at base, tapering to a point and becoming compressed posteriorly, with a keel, or low fin, along the upper median line.

Color variable; above, grayish-clay color, becoming pinkish on the tail, more or less overlaid with dusky spots or mottlings; sides darker, usually with a series of light spots; underside pale, mostly uniform, sometimes mottled with very indistinct gray on the belly.

Dimensions of largest specimen.—Total length, 128 mm.; snout to vent, 72 mm.; vent to tip of tail, 56 mm.; fore limbs, 13 mm.; hind limbs, 17 mm.; snout to fore limbs, 21 mm.; width of head, 12 mm.

Variation.—Among the specimens examined there is but little difference, except that in the larger ones the vomerine teeth are missing, a rather common thing among the species of this genus.

The larger specimens are also duskier and less distinctly marked. The young specimens have brighter colors and more definite markings; thus there is a double series of dusky spots down the middle of the back and another double series on the sides, more or less inclosing the lateral series of light spots, which therefore appear ocellated; there is also a light line from eye to angle of mouth.

Comparison with other species.—Having referred this interesting novelty—which I dedicate to Messrs. H. H. and C. S. Brimley, from whom the Museum has obtained much interesting material—to the genus *Desmognathus*, I need hardly remark that the vertebræ are opisthocœlous and that the premaxillaries are fused together. It will therefore only need comparison with the three species of the genus hitherto recognized, viz, *D. ochrophæa*, *D. fusca*, and *D. nigra*. From the former it is at once distinguished by the shape of the tail, as well as by well-marked differences in the mandibular dentition. From *D. nigra* it can easily be told apart by the number of the costal grooves, not to mention size and color.

From all, including *D. fusca*, it differs in the almost complete obliteration of the gular fold, and from the latter, with which it has the general proportions and external habitus in common, by the faintness of the grooves of the sides of the face and neck, as well as by the absence of the marked glandular swelling on the sides of the neck, so characteristic of *D. fusca*. The whole outline of the head, moreover, is different, it being more rounded and proportionally wider, resembling much more that of *Plethodon glutinosus* than a *Desmognathus*. The maxillary and mandibular alveolar margins are straight, not undulating, and the anterior glandular prolongation of the lower lip is absent. Finally, the palatal dentition is considerably different.

In *D. fusca* the vomerine teeth when present are few, forming two

short arched series behind the choanæ, slightly oblique, converging behind, while the parasphenoid patches are separate their entire length; in *D. brimleyorum* the vomerine series are much larger, nearly parallel posteriorly, diverging anteriorly, while the parasphenoid patches are united in their anterior portion. The latter appears also to be a larger species, although not so large as *D. nigra*, while the coloration approaches closely that of *D. fusca*, except that the lower parts are considerably paler.

AMBYSTOMA ANNULATUM, Cope.

This species was described by Prof. Cope from a single specimen in the U. S. National Museum (No. 11564), the origin of which was unknown. It was consequently not even known with certainty that the species was North American. It was therefore highly interesting to receive from Messrs. Brimley a well-preserved specimen collected at Hot Springs, Ark., thus establishing the habitat of this striking species.

A direct comparison with the type specimen shows the peculiar coloration to be identical, with the trifling exception that in the type the light cross-band from arm to arm is interrupted on the middle of the back, while in the new specimen it is continuous, like the other cross bands. A pale cross band between the eyes, not mentioned in Prof. Cope's description, is present in both specimens. The new specimen is comparatively fresh, and the ground color appears to have been black, the cross bands silvery gray.

There are several structural differences, however, between the two specimens. Thus, in the new specimen, the tail is shorter and somewhat compressed terminally; the vomerine series are longer and extend mesially farther forward. The fourth toe is comparatively shorter.

With only two specimens at hand, the exact locality of one of which is unknown, these differences do not seem important enough to warrant a specific separation, in view of the striking identity of the color pattern, which is absolutely unique in the genus.

DIAGNOSIS OF A NEW GENUS OF TROGONS (HETEROTROGON), BASED ON HAPALODERMA VITTATUM OF SHELLEY; WITH A DESCRIPTION OF THE FEMALE OF THAT SPECIES.

By Charles W. Richmond,

Assistant Curator of the Department of Birds.

Among the many birds sent to the United States National Museum from Mount Kilima-Njaro and other points in East Africa, by Dr. W. L. Abbott, are four very fine specimens of the rare *Hapaloderma** *vittatum*, Shelley, the female of which is, apparently, as yet undescribed. The specimens sent by Dr. Abbott consist of one adult and one immature female and two adult males, all obtained on Mount Kilima-Njaro, between 6,000 and 7,000 feet altitude, during the years 1888 and 1889.

An examination of these specimens, and a careful comparison with the common African trogon (*A. narina*) leads me to believe this species should be removed from *Apaloderma* and recognized as representing a distinct genus. From *Apaloderma narina*, its supposed nearest relative, it differs in several important respects. The bill is very small and slender, and much compressed from above downward, being, in fact, the extreme in this direction, among the Old World trogons. The tomia of both maxilla and mandible are without serrations behind the subterminal notch, the presence or absence of which is an important factor in the recognition of genera in this very homogeneous family. Both *A. narina* and its close ally (probably subspecies), *A. constantia*, have these serrations, they being the only known representatives of the family in the Old World possessing this character. The pattern of coloration in the female of *A. vittatum* differs from that of *A. narina* in that the color of the whole head is unlike that of the male; in the latter species the top of the head is similar to that of the male. Another character, of probably not more than specific importance, is the difference in the pattern of coloration of the tail. In *A. narina* the three outer retrices are white for their exposed portion, while in *A. vittatum* these feathers are conspicuously marked with black and white bars.

In view of these very considerable differences existing between the two species, fully enough, in my estimation, to warrant the adoption of

* Originally spelled *Apaloderma* by Swainson.

a new generic term for *A. vittatum*, I am led to propose for this species the name

HETEROTROGON, new genus.

Diagnosis.—Size medium; form slender; tail long; rectrices not truncate. Three center pairs of rectrices, dark purplish-blue, with metallic reflections, in both sexes; no black terminal bar on middle pair; three outer pairs with black and white bars on their exposed portions. Bill small, slender, and much compressed. Tomia of both maxilla and mandible smooth, without signs of serrations posterior to subterminal notch. Sexes unlike in coloration.

Habitat.—Equatorial Africa, extending across the continent. Apparently confined to the highlands.

Type.—*Hapaloderma vittatum*, Shelley.

The points of distinction between this genus and *Apaloderma*, Swainson, may best be seen by the following key:

a. Bill extremely small and slender; much compressed.
  b. Tomia of maxilla and mandible without serrations posterior to subterminal notch.
    c. Three outer rectrices with bars of black and white.
      d. Female differs decidedly from male on top of head..HETEROTROGON.
a'. Bill large and swollen.
  b'. Tomia of maxilla and mandible with serrations posterior to subterminal notch.
    c'. Three outer rectrices white, for their exposed portions, without bars.
      d'. Female similar to male on top of head...............APALODERMA.

The extreme rarity of *Heterotrogon vittatus* in collections, and the absence of information respecting the female, probably account for its non-separation from *Apaloderma* before the present time. It is unnecessary to compare this genus with *Apalharpactes* or *Pyrotrogon** of the East Indies, as they belong to a different section of the family.

The adult female obtained by Dr. Abbott on Mount Kilima-Njaro, August 7, 1888, at an elevation of 6,000 feet (No. 117973, U.S.N.M.) may be described as follows: Pileum Prout's brown, somewhat darker on lores, with a distinct coppery gloss, except on forehead; this gloss most intense on sides of occiput, where it is reddish bronze; ear coverts slightly darker, with slight greenish reflections, the feathers of normal length with filamentous terminations; suborbital region blackish slate without metallic gloss; back, rump, and upper tail coverts metallic green, quite golden bronze on back, scapulars, and rump, but plain grass green on upper tail coverts. Three inner pairs of rectrices dark

*The name *Harpactes*, Swainson, Class. Birds, II, 1837, p. 337, commonly applied to this genus of trogons, is preoccupied by *Arpactus*, Jurine, Hymen., 1807, and *Harpactes*, Templeton, Arachn., 1834. Cabanis and Heine (Mus. Hein. No. IV, part 1, 1863, p. 154) long ago pointed out the untenability of the name *Harpactes* as used in ornithology, but this fact has been quite generally ignored. Two other names, having priority over *Pyrotrogon*, but preoccupied in other branches of zoology, are *Hapalurus*, Reichenbach, 1850 (*nec Hapalura*, Cabanis, Weigm. Arch., 1847, p. 252), and *Duvaucelius*, Bonaparte, 1854 (*nec Duvaucelia*, Risso, [——?] 1826, and *Duvaucelia*, Desvoidy, Dipt., 1830).

purplish blue, with narrow metallic green edgings on the outer webs; three outer pairs same color, but barred with white on exposed portions, exactly as in the male. Throat, jugulum, and upper breast raw umber, tinged with cinnamon, rather inclining to drab on the throat; sides of neck metallic green as on the back; lower breast russet, the color sharply defined from the raw umber of upper breast and throat; abdomen and crissum geranium red, some of the russet feathers of breast bordering the abdomen also tinged with this color; flanks and tibia, slate; wing, as a whole, dull slaty black, a slight greenish reflection appreciable on tertials and wing coverts; outer edges of second, third, fourth, fifth, and sixth primaries narrowly bordered with white for basal half of exposed portions, and to their insertions; secondaries, tertials, and greater coverts of wing with narrow zigzag bars of white, the bars 0.08 to 0.10 of an inch apart; primary coverts plain dull slate black; middle and lesser coverts dull black, broadly margined with metallic green, the greater coverts and tertials narrowly edged with the same color. Bases of secondaries, tertials, and fifth, sixth, and seventh primaries white, making an irregularly-shaped spot an inch long, on the under surface of the wing; under wing coverts smoke gray. Wing, 4.90; tail, 6.60; tarsus, 0.65; exposed culmen, 0.55; width of maxilla at base, 0.60 inches. "Feet white" (light brown in dried specimen); bill yellowish buff.

Another female, immature, obtained in the same locality, at 7,000 feet altitude, June 10, 1888 (No. 117974, U.S.N.M.), differs from the one just described in the following particulars: Pileum Prout's brown, some of the feathers broadly edged with metallic green, as on the back; lower breast russet, with indistinct buffy edgings to the feathers on the sides, and occasional buff feathers, tipped with dull black (these are feathers of the first plumage); abdomen pale geranium red, sparsely intermingled with buff feathers near median line; under tail coverts cinnamon, with faint mottlings or bars of greenish black (with metallic reflections) on some of the feathers; bars on three outer rectrices irregular and indistinct, the second and third pair with 1.25 inches of unbarred white at terminal end. A few white spots on greater wing coverts, secondaries, and tertials are signs of immaturity; these spots are on the outer webs, near the distal ends of the feathers. Maxilla blackish; mandible yellowish horn color, tip black. Wing, 4.80; tail, 6.50; tarsus, 0.62; exposed culmen, 0.55; width of maxilla at base, 0.55 inches.

The two adult males in the collection agree with published descriptions. They were obtained on Kilima-Njaro, altitude 6,000 feet, one on August 8, 1888, and the other on October 9, 1889. Their measurements are given below:

Measurements of adult males of Heterotrogon vittatus.

U.S.N.M. No.	Wing.	Tail.	Tarsus.	Exposed culmen.	Width of maxilla at base.
117972	4.70	....	....	0.52	0.58
119223	5.00	7.10	0.58	.56	.66

ON THE BOTHRIOTHORACINE INSECTS OF THE UNITED STATES.

By L. O. HOWARD,
Entomologist, U. S. Department of Agriculture.

NO PUBLISHED attempt has been made to divide the large and important chalcidid subfamily Encyrtinæ into tribal groups beyond the suggestion of the writer* of the use of the name Tetracnemini for the Encyrtinæ possessing branched antennæ. There are, however, several natural divisions of the subfamily to which tribal names should be given in any revision of the group. One of these is the group under consideration. The extraordinary sculpture of the head caused the partial association of *Bothriothorax* and *Phænodiscus* in the synoptical tables of Foerster, Thomson, and Mayr, and to these two genera are to be added two others, *Chalcaspis* and *Pentelicus*, based upon undescribed material in the U. S. National Museum.

We unfortunately know nothing of the habits of the new genera, since the few specimens known have all been collected by sweeping. Of *Bothriothorax*, however, the habits are well known, and the species are parasitic upon dipterous larvæ, as follows:

B. clavicornis, Dalman, from *Syrphus* sp. and *Anthomyia ceparum*; *B. peculiaris*, Howard, from Syrphid larva on oak; *B. californicus*, new species, from larva of *Catacomba pyrastri*, Linnæus, feeding on rose aphis; *B. noveboracensis*, new species, from Syrphid larvæ preying upon hop aphis.

We have as yet no American species of *Phænodiscus*; but *P. cercopiformis* and *P. aeneus* of Europe, are said to be parasitic upon Coccidæ.

BOTHRIOTHORACINI, new tribe.

Short, stout-bodied Encyrtinæ, with very large, thimble-like punctation to the very broad and very short head; short, stout legs, with five-jointed tarsi† and broad wings; antennæ inserted below the middle of face, eleven-jointed, funicle joints short, scape slender, or with leaf-like expansion.

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* Proc. U. S. Nat. Mus., xv, 1892, p. 361.

† This seemingly unnecessary statement of the number of the tarsal joints is rendered necessary by the discovery by Aurivillius of a true Encyrtine with four-jointed tarsi (*Arrhenophagus*).

ANALYSIS OF THE GENERA.

Marginal vein very short or wanting.
- Mesoscutum with a sculpture very similar to that of head.
  - Mesoscutum very short, only half as long as scutellum; antennal club as long as all funicle joints together; postmarginal vein as long as stigmal .... CHALCASPIS.
  - Mesoscutum at least as long as scutellum; antennal club shorter than funicle; postmarginal vein much shorter than stigmal ...... BOTHRIOTHORAX.
- Mesoscutum with punctures less dense than those of head, and with a plain shagreening of the surface; antennal club shorter than funicle; postmarginal and stigmal veins short, subequal .... PENTELICUS.

Marginal vein long, rarely shorter than stigmal; mesoscutum shagreened, with sparse punctures .... PHÆNODISCUS.

CHALCASPIS, new genus.

Female.—Body very short and very stout; head very thin antero-posteriorly, very broad (laterally); eyes long oval, very widely separated, faintly hairy; face very convex, not furrowed; occipital border very sharp; genal sulcus distinct, widely open at eye border; ocelli indistinct, at the corners of a very obtuse angled triangle, lateral ones near the eye border. Antennæ inserted at border of mouth; scape slender, not broadened, rather short; flagellum rather longer than scape; first funicle joint shorter than pedicel, remaining funicle joints not longer than wide; club large oval, slightly obliquely truncated, as long as all funicle joints together. Pronotum nearly covered by occipital border of head. Mesoscutum very short. Mesoscutellum long and broad, twice as long as scutum, nearly flat, rather pointed, with entire border emarginate; axillar sutures very indistinct, axillæ meeting at tips. Abdomen very short and broad. Legs stout. Wings short and broad; submarginal vein reaches costa at about one-half wing length; marginal vein lacking; stigmal long, curved; radial angle narrow; postmarginal as long as stigmal.

CHALCASPIS PERGANDEI, new species.

Female.—Length, 1.3 mm.; expanse, 3.4 mm.; greatest width of forewing, 0.59 mm. Punctation of head (except the smooth occiput), mesocutum, and mesoscutellum nearly uniform throughout, the punctures round, lengthened somewhat posteriorly on scutellum; tegulæ smooth, with a shallow fovea at inner base; mesopleura finely shagreened; rest of body smooth. Funicle joints of antennæ short, all broader than long, increasing in length and breadth from 1 to 6. Head, pronotum, and mesonotum greenish or coppery in color, with strong metallic reflections; eyes dark red or black, mandibles black; antennal scape honey yellow with black bulbus; pedicel and club dark brown or black; funicle joints honey yellow, joint 1 darker than the others. Pleura and abdomen metallic with greenish or bluish luster. All coxæ metallic; all femora, tibiæ, and tarsi honey yellow. Entire forewing slightly infuscated.

Described from four female specimens, two collected by Mr. Theodor

Pergande, in the District of Columbia, in July and August, 1878, one taken by myself in September, 1884, and one captured by Mr. J. M. Aldrich, in South Dakota. All in the U. S. National Museum collection. I have also seen two females in the collection of the American Entomological Society at Philadelphia.

Genus BOTHRIOTHORAX, Ratzeburg.

Bothriothorax, RATZEBURG, Ichneumonen d. Forst-insekten, I, 1844, p. 208.—FOERSTER, Hymenopterologische Studien II, 1856, p. 32.—SUELLEN VAN VOLLENHOVEN, Schetsen, 1871, Tab. VII.—THOMSON, Hymenoptera Scandinaviæ, IV (1875), p. 133.—MAYR, Die Europaische Encyrtiden, 1875, p. 80 (754).

Female.—The body is rather broad and flattened. The antennæ arise not far from the border of the mouth; the scape is quite long and not flattened; the pedicel is as long as or longer than the first funicle joint; this last is as long as or longer than thick; the club is shorter than the funicle or (with *B. paradoxus*) twice as long. The face is delicately impressed; vertex and clypeus are very broad, and the ocelli form a very obtuse-angled triangle. The thin (antero-posteriorly) broad (laterally) head is very deeply punctured, as are also mesonotum and scutellum; in the center of each puncture is a little papilla, from which springs a delicate hair; besides this, there is a leather-like sculpture. The mesoscutum and scutellum are rather strongly transversely arched, and the lateral borders of the latter are quite sharp. The ovipositor is not at all, or very slightly, extruded. The marginal vein of the hyaline wings is very short, or is lacking; the stigmal is long, and the postmarginal is short, or very short; radial angle wide.

Male.—Very similar to the female and only distinguished by the antennæ and by the sparser punctuation of the head. The pedicel is short, somewhat longer than thick; the funicle quite lengthened, and the joints small and strongly concave beneath, so that the funicle appears somewhat toothed above; most of the joints have two half whorls of long hair; the club is almost as long as the last two funicle joints together.

ANALYSIS OF THE SPECIES OF BOTHRIOTHORAX.

Punctures of mesonotum deep but very irregular, giving a strongly rugose appearance .... VIRGINIENSIS.
Punctures of scutum quite round and regular.
  Axillæ meet at tips .... PECULIARIS.
  Axillæ separated at tips:
    Scutellum more or less emarginate at tip.
      Scutellum nearly uniformly punctured.
        Emargination of tip of scutellum faint; antennæ rather long and slender .... NOVEBORACENSIS.
        Emargination very distinct; antennæ short and stout. CALIFORNICUS.
      Normal punctation of scutellum ceases on posterior third, and is replaced by delicate longitudinal aciculation; emargination of tip slight .... NIGRIPES.
    Scutellum not emarginate at tip.
      Notum transversely and longitudinally convex; vertex rounding up between the eyes .... ROTUNDIFORMIS.
      Notum nearly flat; vertex flat .... PLANIFORMIS.

BOTHRIOTHORAX VIRGINIENSIS, Howard.

Bothriothorax virginiensis, HOWARD, Bull. 5, Div. Entom., U. S. Dept. Agric., 1885, p. 20.

Female.—Length, 1.63 mm.; wing expanse, 3.96 mm.; greatest width of forewing, 0.69 mm. Face and vertex with large, round, thimble-like punctures, each with a central umbilicus, becoming sparser on lower face and more elongate. Cheeks also faintly shagreened; punctation of mesoscutum more irregular than on vertex, individual punctures elongated and more or less irregular; mesoscutellum like scutum, except that it is aciculate at base. Abdomen smooth; pleura smooth; eyes faintly hairy; antennæ regularly clavate; pedicel longer than first funicle joint, which is a little longer than broad; remaining funicle joints increasing slightly in width and in length; club slightly longer than sixth funicle joint. Color metallic greenish black; antennæ jet black; all coxæ metallic; all femora metallic, brownish at tip; front and middle tibiæ brownish yellow, hind tibiæ greenish black; all tarsi yellow; wing veins light brown.

Described from one female specimen collected September 18, 1881, at Arlington, Va. Type in the U. S. National Museum.

BOTHRIOTHORAX PECULIARIS, Howard.

Bothriothorax peculiaris, HOWARD, Bull. 5, Div. Entom., U. S. Dept. Agric., 1885, p. 20.

Female.—Length, 1.75 mm.; expanse, 4.25 mm.; greatest width of forewing, 0.7 mm. Axillæ meet at tips, face uniformly punctate, cheeks behind genal sulcus impunctate, faintly shagreened; punctures of mesonotum supplemented by faint granulation; scutellum nearly smooth at tip, faintly emarginate; tegulæ faintly granulate, abdomen and pleura smooth. First funicle joint of antennæ somewhat shorter than pedicel; funicle joints subcylindrical, increasing in diameter from one to six; joint six as thick as long; club as long as three preceding funicle joints together, much flattened and sharply, somewhat obliquely, truncate at tip. General color blue green; basal half of antennal scape honey yellow; distal half black above, yellowish below: flagellum black with green luster; middle and hind femora honey yellow; front and middle tibiæ honey yellow; hind tibiæ black; all tarsi honey yellow; wing veins light brown.

Male.—Antennæ much longer and more slender than those of female; pedicel twice as long as thick; joint one of funicle three times as long as thick, and one-third, or a little more, longer than pedicel; other funicle joints subequal in length, about as long as pedicel, well separated and increasing slightly in thickness; club flattened, very obliquely truncate, and nearly as long as two preceding funicle joints together; all joints clothed with short, close hair. In coloration similar to female, except that the antennæ and front femora are honey yellow throughout.

Described from three females and ten males, reared in November from a Syrphid larva, found on an oak leaf at Arlington, Va. Types in the U. S. National Museum.

BOTHRIOTHORAX NOVEBORACENSIS, new species.

Female.—Length, 1.6 mm.; expanse, 3.8 mm.; greatest width of forewing, 0.7 mm. Axillæ well separated at tips; punctation of head as with preceding species; same with that of mesonotum and scutellum. Axillæ nearly smooth, scutellum faintly emarginate at tip, tegulae smooth, eyes faintly hairy; marked depression at central hind border of mesoscutum; abdomen faintly shagreened, mesopleura smooth, antennæ more slender than with preceding species; joint 1 of funicle one-half length of pedicel; joints 2 to 6 increasing slightly in width and length; club obliquely truncate, as long as the two preceding funicle joints together. General color bright metallic blue-green; tegulæ light brown at tip, somewhat metallic at base; antennal scape honey-yellow at base, brown toward tip; flagellum brown; all legs honey-yellow, front and middle femora brownish, hind tibiæ black, all coxæ metallic; wing veins brown.

Described from two female specimens, one collected on hop at Richfield Springs, N. Y., by Mr. Theodor Pergande, October 7, 1887, close to a Syrphid larva, and the other by Mr. Koebele at Boscawen, N. H., October, 1884. The measurements apply to the New York specimen; the New Hampshire specimen is considerably larger. Types in the U. S. National Museum.

BOTHRIOTHORAX CALIFORNICUS, new species.

Female.—Length, 1.75 mm.; expanse, 4.4 mm.; greatest width of forewing, 0.8 mm. Axillæ well separated at apex, scutellum distinctly emarginate, eyes plainly hairy; head punctured as with preceding species, facial depression slightly marked. Scutum and scutellum similarly punctured, the punctations on the side of the scutellum becoming somewhat elongate, less so in the center, the punctations with shagreened center; punctures lacking at extreme tip of scutellum, but shagreening persistent. Axillæ nearly smooth, with one or more faint depressions; tegulæ shagreened on basal half. Abdomen smooth, except second segment, which is faintly shagreened. Occiput rather strongly shagreened, mesopleura smooth. Antennæ short, stouter than with preceding species; flagellum not more than one-third longer than scape; first funicle joint one-half as long as pedicel; joint 2 equal to joint 1, joints 3, 4, 5, and 6 becoming each a little longer and a little wider than its preceding joint. Club flattened, obliquely truncate nearly to base, and as long as three preceding funicle joints together. General color metallic bluish-green, tegulæ also metallic, antenæ black throughout, all legs dark brown, hind tibiæ metallic, middle and fore tibiæ lighter toward tip; all tarsi honey yellow; wing veins brown.

Described from three female specimens reared by Albert Koebele at Alameda, Cal., in July, from pupa of *Catacomba pyrastu*, Linnæus, among aphides on rose. Types in the U. S. National Museum.

BOTHRIOTHORAX NIGRIPES, new species.

Female.—Length, 2.2 mm.; expanse, 5 mm.; greatest width of fore-wing, 0.93 mm. Axillæ well separated; eyes, naked, scutellum slightly emarginate; head punctured as with preceding species, facial depression not marked; punctation of scutum and scutellum like that of head, except that posterior one-third of scutellum bears no large punctures, but is very finely and longitudinally shagreened or aciculate. Axillæ smooth, except for two large round punctures side by side on the wider portion of each. Tegulæ as with preceding species. Entire surface of abdomen faintly shagreened; pleura smooth; occiput as with preceding species. Antennæ as with the preceding species, except that the first funicle joint is as long as the pedicel. General color metallic bluish-green, with strong bronze reflections on thorax, these reflections being given off from the interspaces between the punctures. Base of antennal scape brownish, remainder of antennæ black; tegulæ black; all legs black, except that the tarsi are honey-yellow, and fore tibiæ are light brown; wing veins light brown.

Described from two female specimens, one collected on cabbage at Las Cruces, N. Mex., by Mr. T. D. A. Cockerell, and the other collected at Los Angeles, Cal., by Mr. D. W. Coquillett. Types in the U. S. National Museum.

BOTHRIOTHORAX ROTUNDIFORMIS, new species.

Female.—Length, 1.7 mm.; expanse, 4.3 mm.; greatest width of fore-wing, 0.85 mm. Scutellum not emarginate at tip; axillæ well separated at tips; notum of thorax transversely and longitudinally convex (a character which this species possesses in common with, though in rather more marked degree than, all the preceding species, but in which it differs radically from the following species). Head punctured as with preceding species, occiput transversely shagreened, facial depression well marked, transversely rugose; eyes faintly hairy. Scutum punctured like head, scutellum similarly punctured anteriorly, punctures becoming fainter toward tip, which is delicately transversely shagreened; axillæ with several small faint impressions; tegulæ smooth; pleura smooth; abdomen smooth, ovipositor very slightly exserted; antennæ, as with *californicus*, not so thickly clothed with pile as most of the other species. General color metallic bluish green; tegulæ dark brown, somewhat metallic at base; antennæ dark brown, with scape yellowish at base. All coxæ metallic, hind femora metallic, middle and front femora dark brown at middle, yellowish at tips; front femora rather darker than middle. Front and middle tibiæ honey-yellow, hind tibiæ nearly black, all tarsi honey-yellow, except apical

joints. Wing veins brown, with darker spot at juncture of submarginal and stigmal.

Described from one female specimen taken in Placer County, Cal., by A. Koebele, in August. Type in the U. S. National Museum.

BOTHRIOTHORAX PLANIFORMIS, new species.

Female.—Length, 1.8 mm.; expanse, 3.9 mm.; greatest width of fore-wing, 0.8 mm. Axillæ nearly touching, scutellum not emarginate, eyes plainly hairy; notum of thorax flat, mesoscutum and scutellum in same plane. Head punctured as with preceding species on front and vertex; facial depression very distinct, occupying nearly all of lower half of face, depression irregularly shagreened; face between depression and genal sulcus, rugose; cheek behind sulcus faintly longitudinally shagreened. Punctures of mesoscutum rather small and less pronounced than those of the head, but dense and accompanied by faint shagreening; on mesoscutellum punctures become much sparser, and the shagreening, which takes a longitudinal direction, much more marked. Axillæ with many small punctures; tegulæ faintly shagreened over entire surface; mesopleura distinctly shagreened, especially on anal half. Abdomen smooth at sides, faintly shagreened above and below, ovipositor distinctly exserted. Both scape and flagellum of antennæ rather longer than in preceding species; first funicle joint longer than second and rather shorter than pedicel; third and fourth equal to second; fifth, and sixth equal to first; club as with preceding species. General color black, faintly metallic, mesoscutellum with faint coppery luster, facial depression with brilliant purple luster; tegulæ black, somewhat metallic, middle tibiæ becoming lighter toward tip; tarsi as usual yellowish, with black apical joints. Wing veins brown, stigmal and short projection of submarginal darker than submarginal.

Described from one female specimen collected in Placer County, Cal., by A. Koebele, in August. This species resembles *Phænodiscus* in punctation of mesoscutellum, but in venation and other respects belongs to *Bothriothorax*. Type in the U. S. National Museum.

BOTHRIOTHORAX PECKHAMII, Ashmead.

Bothriothorax peckhamii, ASHMEAD, Trans. Amer. Ent. Soc., XIII, 132.—CRESSON. Synopsis Hymenoptera North America, pt. ii, p. 240.

This species, Mr. Ashmead informs me, is not a *Bothriothorax*. He has kindly allowed me to see the type, and it seems to form a new genus near *Comys*, but lacks the scutellar tuft.

PENTELICUS, new genus.

Female.—In habitus this form is intermediate between *Bothriothorax* and *Chalcaspis*, but has the shagreened mesonotum of *Phænodiscus*, the round punctures of the mesonotum, however, being rather close instead of sparse. It is not so short and broad as *Chalcaspis*. The

head resembles that of *Chalcaspis*; the ocelli are similarly placed, the eyes are shorter, more rounded, and hairy; facial depression well marked, genal sulcus plain but not widely opened at eye-border, as in *Chalcaspis*. Mesoscutum is nearly as long as scutellum; axillæ are very difficult to distinguish and are widely separated at tips; scutum and scutellum rather closely punctate, with plain shagreening in addition. Scutellum rather flat, margined round entire free border, and with a delicate central longitudinal carina. Antennæ resemble those of *Bothriothorax*. Forewings broad and rather short, stigmal given off before submarginal reaches costa, postmarginal about as long as stigmal; both, however, short. Radial angle narrow. Abdomen short, triangular, rather sharply pointed at tip.

PENTELICUS ALDRICHI, new species.

Female.—Length, 1.5 mm.; expanse, 2.8 mm.; greatest width of forewing, 0.6 mm. Punctation of front divides at top of facial depression and runs in a narrow band down below each eye. Walls of facial depression faintly shagreened, the shagreening continuing in a longitudinal manner upon the cheeks, each side of the genal sulcus and so around upon the occiput. Mesoscutum with punctures lacking upon its anterior border. Tegulæ smooth; abdomen smooth; mesopleura faintly shagreened. Antennæ with indistinct joints, funicle joint one nearly as long as pedicel; funicle joints subequal in length, but increasing in width to flattened and very obliquely truncate club, which is as long as two preceding funicle joints together. General color somewhat metallic greenish-black; face highly metallic, with greenish-bronzy reflections, facial depression with bright green reflections; mesonotum much duller. Tegulæ black, antennæ dark brown or black, scape honey-yellow. All femora and tibiæ black, with yellowish extremities; trochanters yellowish; tarsi light honey-yellow, with black apical joints.

Described from one female specimen collected in South Dakota by Mr. J. M. Aldrich. Type in the U. S. National Museum.

Genus PHÆNODISCUS, Foerster.

Phænodiscus, FOERSTER, Hymenopterologische Studien, II., 1856, p. 144.

Discodes, FOERSTER, Hymenopterologische Studien, II, 1856, p. 32.—SUELLEN VAN VOLLENHOVEN, Schetsen, 1871, Tab. VII.

Phænodiscus, THOMSON, Hymenoptera Scandinaviæ, IV, 1875, p. 136.—MAYR, Europaische Encyrtiden, 1875, p. 83.

No American species of this genus have yet been found. So many European genera, however, have already been recognized that it is probably only a question of time before species of this genus will be found to occur in the United States. I know the genus only through a single male specimen of *P. æneus*, Dalman, given to me by Dr. Mayr, and am therefore obliged to repeat here this author's comprehensive description of the genus.

Female.—Body short, moderately broad; antennæ inserted not far

from mouth border; scape rather short, with no leaf-like expansion; pedicel is shorter or longer than first funicle joint; funicle moderately compressed or almost entirely cylindrical; club as long as two or three last funcicle joints together. Facial depression slight; genal sulcus sharp, reaching from the eye to the mouth border; front and vertex very broad; ocelli at the corners of an obtuse-angled triangle; head thickly and very coarsely punctate; mesoscutum and scutellum rather strongly shagreened, with sparse hair-bearing punctures; pleura shagreened, not glistening; axillæ of the slightly arched scutellum meet at tips; ovipositor entirely or almost entirely hidden Wings wholly or partly infuscated. Marginal vein is as long as or somewhat shorter than stigmal, never very short; postmarginal variable in length.

Male.—Somewhat like the female; scape short, pedicel as long as broad; funicle joints and club subequal in thickness, with short and rather close pile; sculpture of the head is lighter and sparser than in the female, the thorax also with finer sculpture; scutellum, especially behind, more strongly arched than with female; wings not infuscated; venation like female.

ADDENDUM.

Walker's genus *Aenasius*, just redescribed by the writer,* belongs to this new tribe. It differs at once from the genera here described by possessing a broad leaf-like expansion to the antennal scope. It is a monotypical genus, and has been found only on the island of St. Vincent, B. W. I.

* Journal Linnæan Society, xxv, 1894, p. 88.

NOTES ON THE GEOGRAPHICAL DISTRIBUTION OF SCALE INSECTS.

By T. D. A. Cockerell.

In the preparation of a list of localities from which Coccidæ have been recorded it becomes so evident that our knowledge is not merely incomplete, but fragmentary, that further consideration of the matter at the present time might seem useless. I do not. however, take this view, but prefer to record the fragments of information so far accumulated, hoping that those who read these notes may be in some cases stimulated to assist in filling the gaps.

PALEARCTIC REGION.

Although Europe has been apparently well searched, new things are turning up every few months, and I really believe that we do not know the Coccidæ of any European country so well as we do those of New Zealand. There are two or three reasons why the European list, as appearing in the books, must be considerably reduced. One is that there is doubtless a good deal of synonymy not yet clearly made out, owing to the formerly prevalent idea that it was safe to consider anything on a new food plant to be a new species. Another is the number of imperfect descriptions of older authors, which, in the absence of certainty as to what was intended, will have, eventually, to be dropped. The third reason is that very many species described from Europe have been found in hothouses on exotic plants, and certainly do not belong to the palearctic fauna. When Signoret wrote, these hothouse species already numbered 48, and they have been largely added to since by Douglas and Newstead.

Making as good an estimate as I am able to at present, I find the truly palearctic Coccidæ to be as follows:

Porphyrophora, 5; *Guerinia*, 1; *Palæococcus*, 2; *Nidularia*, 1; *Antonina*, 2; *Xylococcus*, 1; *Gossyparia*, 2; *Eriococcus*, 6; *Rhizococcus*, 1; *Bergrothia*, 1; *Oudablis*, 2; *Dactylopius*, 11; *Puto*, 1; *Phenacoccus*, 12; *Ripersia*, 4; *Tetrura*, 1; *Cryptococcus*, 1; *Kermes*, 9; *Orthezia*, 5; *Asterolecanium*, 5; *Pollinia*, 2; *Lecaniodiaspis*, 1; *Signoretia*, 1; *Fillippia*, 1;

Eriopeltis, 3; *Lichtensia*, 1; *Pulvinaria*, 17; *Ceroplastes*, 2; *Physokermes*, 1; *Lecanium*, 32; *Lecanopsis*, 2; *Spermococcus*, 1; *Aclerda*, 1; *Exæretopus*, 1; *Fairmairia*, 1; *Aspidiotus*, 25; *Diaspis*, 8; *Aulacaspis*, 1; *Mytilaspis*, 9; *Pinnaspis*, 1; *Chionaspis*, 9; *Leucaspis*, 5; *Fiorinia*, 1; *Aonidia*, 2.

Thus the palearctic region has about 200 species (some of doubtful validity) which appear to be native to it. This is not a very good showing when we remember that even in the nearctic region, where we must have a lively sense of our ignorance, we recognize about 120, although, it must be confessed, many of these can not be claimed as native.

Turning, now, to the several portions of the palearctic region, the facts are still more striking. The great majority of the species is from France, the country of Signoret, Boisduval, Lichtenstein, and other coccidologists. In early times Bouché described species from Germany, and still earlier we have the "Fauna Boica" of Schrank. The species of Schrank, being found in Austria, were in later days elucidated by Loew. In Italy there was Targioni-Tozzetti, but this author frequently omitted to give the descriptive information necessary for the identification of names bestowed, these omissions, happily, being mostly supplied by Signoret. At the present time Berlese, in Italy, and Giard, in France, are publishing on Coccidæ.

In the Spanish peninsula, about ten years ago, some species were described by P. Colvée, and later than that Mr. A. C. F. Morgan, residing at Oporto, has studied the group, though not adding very much to the fauna of his locality.

In Greece some contributions have appeared from Gennadius, who also favors us with a record of *Aspidiotus aurantii* (his *coccineus*) from the Island of Chios, off the coast of Asia Minor. The same insect has been reported by Shipley from Cyprus, and is stated to occur in Syria. The mainland of Asia Minor furnishes one species, *Dactylopius caricus*, described in 1883 by Gennadius.

From Egypt we know little, but Signoret described therefrom his *Ceroplastes mimosæ;* and more recently we have the *Icerya ægyptiaca* of Mr. Douglas, which may, however, be really a native of India.

Algeria has furnished two species of *Asterolecanium* on bamboo, but these doubtless belong really to the tropics, where they have since been found. *Guerinia serratulæ*, reported by Signoret, is more probably native there. Just lately M. Giard has named from Algeria two species, *Lecanium asparagi* and *Diaspis asparagi*, but I am not aware that the descriptions have yet appeared.

Madeira and the Canary Islands now furnish the imported *Coccus cacti*, but their native coccid fauna is unknown. If my recollection is correct, *Mytilaspis pomorum* was found apparently native in the Canaries by Mr. D. Morris recently.

Taking the more northern parts of Europe, there is the "scarlet

grain of Poland," but I do not recall any records of native species in Russia proper with the exception of *Gossyparia mannifera*. It is also reported from Egypt, Arabia, Armenia, and Algeria. Holland supplies *Eriopeltis lichtensteinii*. The Scandinavian peninsula, since Linnæan time, has been neglected, though we have the *Chionaspis sorbi*, Douglas, from Finland.

Germany was alluded to above, but a paper by R. Goëthe on the Coccidæ of the Rhine district, published in 1884, should be mentioned. When I was in Jamaica, Mr. C. Schaufuss, of Neissen, Saxony, sent me a number of Coccidæ because, he said, there was no one in Germany who could identify them. Happily, since then, a new student has arisen in Bohemia, Mr. K. Sulc, and from his energy and zeal we may look for great additions to our knowledge. Mr. Newstead has just described *Fiorinia sulci*, found by him, which is the first undoubtedly palearctic *Fiorinia*.

Finally, the British Isles have to be considered. Work done in earlier times by Westwood, Curtis, Hardy, and a few others, was only fragmentary in its nature, and did not afford a basis for a good knowledge of the insular coccid fauna. After the publication of Signoret's Essai in France, the way was clearly open for some student to elucidate the British species; but instead of a new writer, Mr. J. W. Douglas, already a veteran in entomology, came forward, and has for the last ten years produced papers in rapid succession on the subject. Still more recently, however, we have a new student in Mr. Newstead, and it is to him we must look for the first revisional monograph of British Coccidæ.

Passing eastward into the Asiatic portion of the palearctic region, we are met by a total absence of information, excepting the before mentioned records from Asia Minor and Syria, and a *Porphyrophora* long ago made known from Armenia. On the southern border, in a region perhaps rather Oriental than palearctic, we have the lately described *Pollinia grandis*, Newstead, from Beloochistan, where it was discovered by Lieut. R. Tomlin.

At this point it seems desirable to urge the importance of getting some knowledge of the Coccidæ of Japan. In California certain species are said to have been imported from Japan, but we have no knowledge, apparently, of the coccid fauna actually existing in that country. Japanese fruits are now often imported into the United States, and the possibility of importing Japanese Coccidæ must be carefully considered. Prof. Gillette recently sent me an *Aspidiotus* found on a plum at Canyon City, Colorado. I do not know the species, but think it may probably be Japanese.

ETHIOPIAN REGION.

If, as seen above, our knowledge of palearctic Coccidæ is still small, how absurdly small is that of the coccid fauna of the Ethiopian region—a region which one might expect to teem with interesting

species. The known species are less than half the number of those found in Jamaica.

From Tangier to Cape Town, all down the west coast, I find no record by recent writers; only the *Monophlebus raddoni*, Westwood, described from a male.

At the north, perhaps better recorded in the palearctic list, is *Aonidia blanchardi*, Targioni-Tozzetti, on the date palms of the Sahara.

At the Cape we have the old Linnæan *Ceroplastes myricæ* and the *Coccus diosmatis*, neither of which are now positively recognized. R. Trimen, in 1886, wrote on a supposed species of *Margarodes* found with termites and ants. More lately there are signs of awakening interest from this part of the world, and new species are gradually falling into the hands of coccidologists. Thus we have *Ortonia natalensis*, Douglas, and *Dactylopius graminis*, Maskell, both from Natal.

On the eastern coast the same lack of information is found, although, indeed, *Dactylopius bromeliæ* comes from Zanzibar.

It need hardly be said, after this, that the central portions of the continent are virgin ground, as likewise is Madagascar, though there is a possibility that one or two of the hothouse species may really be from that island.

For Mauritius we have Icery's researches, dating from 1864, and made ever famous by the name *Icerya*. In 1868 Guérin-Méneville, taking up the same subject, treated the Coccidæ infesting sugar cane in Mauritius and Réunion. He recognized three Coccidæ and an *Aleyrodes*. In 1872 Signoret added *Ceroplastes vinsoni* to the Mauritius fauna.

Icerya seychellarum, Westwood, the *I. sacchari* of Signoret, is found in the Seychelles, Bourbon, Rodriguez, and Mauritius, and, it is said, also in Madeira, of course there introduced.

There is still one more record, Mr. Butler's *Coccus cerataformis* from Rodriguez. Unfortunately, we do not know to what genus this insect belongs. It is no *Coccus* in the Signoretian sense. *Vinsonia stellifera* is recorded from Réunion.

ORIENTAL REGION.

Putting aside the species of which the generic position is unknown (that is, the last century of Coccidæ of Anderson), I find described from the Oriental region the following:

Walkeriana, 1; *Monophlebus*, 4; *Drosicha*, 1; *Dactylopius*, 3 (including two of Mr. Newstead's species, about to be published); *Coccus*, 1 (introduced); *Orthezia*, 1; *Tachardia*, 1; *Eriochiton*, 1; *Pulvinaria*, 1 (not published, described by Newstead); *Pseudopulvinaria*, 1; *Vinsonia*, 1 (*V. stellifera*, said to come from Siam, also Réunion); *Ceroplastes*, 1; *Ericerus*, 1; *Lecanium*, 4; *Aspidiotus*, 4 (1 of Mr. Newstead's waiting publication); *Chionaspis*, 2.

A total of 28, for such a region as the Oriental! It is less than half

of those known from Jamaica. Even adding eight unrecognizable species of "*Coccus*" (seven by Anderson, one by W. F. Kirby) the total is only 36; still only about half the total for Jamaica.

The Jamaican total, however, includes species believed to have been introduced; so, to make the comparison fair, we should add to the Oriental list *Diaspis lanatus* (in Ceylon), *Icerya ægyptiaca* (Madras, possibly native), *Dactylopius bromeliæ*, as identified by Maskell (in Bengal on mulberry), and *Chionaspis braziliensis* (in Ceylon), as well as the long established *Coccus cacti*, which I had already included, thus bringing the Oriental list to a total of 40.

Coming now to the several faunæ, we may take first the islands. The Malay region is almost totally unexplored for Coccidæ, yet what a rich harvest it would surely yield! From Sumatra we have the old *Monophlebus dubius*, Fabricius (*fabricii*, Westwood), and from Java *Monophlebus atripennis*, Klug. We learn from Watt (Dictionary of Economic Products of India) that *Coccus cacti* has been introduced in Java, and are there referred for further information on this point to a work I have not seen, "Veth's Woordenboek von Nederlandsch Indie-Cochenille."

Beyond these records I can not recollect a single species as mentioned from any Malayan island; nothing from Borneo, Celebes, or the Philippine Islands.

For the Laccadive Islands we have Maskell's records of *Dactylopius cocotis* and *Aspidiotus destructor*; but for the Andamans, Nicobars, and Maldives I have seen no records.

For Ceylon we have several records. In addition to the two above mentioned, we may refer to *Walkeriana floriger*, Walker, "*Coccus*" *laniger*, Kirby, *Lecanium coffeæ*, Walker, *L. mangiferæ*, Green, *L. viride*, Green, *Orthezia nacrea*, Buckton, *Aspidiotus transparens*, Green (? = *A. nerii*, says Mr. Green), *Aspidiotus theæ*, Green (which Mr. Green informs me consists of a female *Chionaspis biclaris*, Comstock, and a male *Chionaspis* sp.), and *Aspidiotus flavescens*, Green (which Mr. Green says in a recent letter is a *Diaspis*). The last three were figured in a little book on Insect Pests, by E. E. Green, published in 1890; they all infest the tea plant. It may be well here to mention, also, that in 1886 Mr. Green published a four-page pamphlet, with a colored plate, treating of the three species of *Lecanium* infesting coffee, namely, *L. nigrum*, *L. coffeæ*, and *L. viride*. It is to be remarked that this publication of *L. viride* considerably antedates that by Mr. Green in the Entomologists' Monthly Magazine (1889, p. 248), where it nevertheless appears as a new species.

It is most fortunate for Oriental coccidology that within the last year or so Mr. Green has commenced to work out the Coccidæ of Ceylon in earnest, so that inside of a reasonable time we may expect to be well informed regarding the species of that island. As might be expected, he has found many interesting new species, several of which he has

been so good as to send me. Such are a *Mytilaspis* with a bright lilac male; a bright reddish orange *Monophlebus* on *Antidesma;* a *Lecanium* in nests on *Cremastogaster dohrni*, Mayr; an omnivorous *Pulvinaria* resembling, but distinct from, *P. cupaniæ;* a *Ceroplastes* on cocoanut, and others. In a letter dated April 3, 1894, Mr. Green states that he has already collected, figured, and described (in manuscript) more than 60 species. These, he adds, include the following genera:

Walkeriana, Monophlebus, Icerya, Eriococcus, Dactylopius, Pseudococcus, Orthezia, Pulvinaria, Vinsonia, Ceroplastes, Lecanium, Carteria, Asterolecanium, Aspidiotus, Diaspis, Mytilaspis, Chionaspis, Fiorinia, and *Aonidia.*

The mention of *Asterolecanium* reminds me that Mr. Green has sent me four species from Ceylon. Three are new and the fourth is *A. bambusæ*, new to the Oriental region, but very probably really native there.

A *Ceroplastes*, which he finds on tea and other shrubs, is thought by Mr. Maskell to be *C. rusci*, but the identity is perhaps open to question.

From Ceylon we naturally pass to India. Here we have several records, as in Ceylon, but no approximately complete information. In the last century (1786–1789) Anderson, in his letters to Banks, described the Coccidæ of Madras, but unfortunately none of his species can now be recognized, except the *Ceroplastes ceriferus* described in 1791. Perhaps some may yet be identified when we know the Coccidæ of India better. For about a century the subject was allowed to drop in India, though we have Westwood's Malabar *Monophlebus leachi*, and references to the lac and wax producing species, and likewise to those infesting coffee. Mr. Atkinson, in 1889, gave us his *Pseudopulvinaria sikkimensis* from Sikkim, and most probably, had he lived, he would have by this time added considerably to our knowledge of Indian Coccidæ. From Mr. Atkinson and Mr. Cotes a few species have been sent to Mr. Maskell, who has described and figured them.

Finally, Mr. Newstead has been studying some Indian Coccidæ, and although his work has not, so far as I know, yet appeared, he has kindly sent me photographs of some very beautiful drawings which will accompany it.

In this summary of Indian coccidology I may have overlooked some publications which have appeared in that country and have not been seen by me, but I am fairly confident that nothing important, such as a new species, has been missed.

In Assam is found *Aspidiotus theæ*, Maskell. This is not Green's Ceylon *A. theæ*, but the name may remain, since the Ceylon insect is not an *Aspidiotus.*

In the Transactions of the New Zealand Institute for 1891, Maskell records *Chionaspis aspidistræ*, Signoret from India (on *Areca*), a fact which I had overlooked when writing the above, and also gives *Chionaspis theæ*, Maskell, as from "the Kangra Valley, Assam." It does not appear, however, that *C. theæ* is found in Assam at all, but in the

Kangra Valley, which, to the best of my knowledge, is in Punjab. *Aspidiotus theæ* is found both in Punjab and Assam.

Except the Beloochistan record previously alluded to, I find no other information regarding Coccidæ of the oriental mainland, save one or two from China.

Of course, the lac industry has quite a literature of its own, and it is well known that all the lac does not come from India proper. I have a copy of a manuscript written in 1840 by William Jones, the Jamaican entomologist, alluding to the lac from Siam and Pegu.

From China we have *Ericerus pe-la*, the Chinese wax insect; *Aspidiotus gossypii* of Fitch, from Ningpo, apparently a *Chionaspis; Drosicha contrahens* (Walker) Signoret, reported also as from Ceylon, and Walker's "*Aspidiotus bicarinatus*," which is a dried caterpillar!

AUSTRALIAN REGION.

Here we pass from darkness into light, thanks to the untiring and faithful labors of Mr. Maskell.

Putting aside Australia and New Zealand, we may commence with the smaller islands, concerning which very little is known. From New Guinea I find no records except that of *Myxolecanium kibaræ*, the description of which I have not yet had the good fortune to see. It dates from 1877.

For New Caledonia we have another monotypic form, the *Tessarobelus guerinii*.

From the Fiji Islands Maskell has received some species, and so records *Dactylopius cocotis*, *Lecanium chirimoliæ* (=*longulum*), *Diaspis pinnulifera*, *Dactylopius calceolariæ*, and *Planchonia bryoides*. In Insect Life, III, p. 253, *Mytilaspis citricola* is reported on oranges from Fiji. From Tonga, Mr. Maskell records *Chionaspis citri*, found by Mr. Koebele. From Samoa *Aspidiotus cydoniæ* was received on oranges.

In Tahiti the Coccidæ are not known; nevertheless, *Chionaspis biclaris*, *Mytilaspis citricola*, and *Aspidiotus aurantii* have been reported as found on trees received from that island.

The Sandwich Islands, though singularly poor in insects, may be found to yield a fair number of Coccidæ. Mr. Maskell has already given us some information about Sandwich Island species, and one or two other writers have alluded to the subject, so that we know of at least the following species: *Dactylopius citri*, on orange trees from the Sandwich Islands, *Lecanium hesperidum*, *L. depressum*, *L. oleæ*, *L. acuminatum*, *Asterolecanium pustulans*, *Pulvinaria psidii*, and *Sphærococcus bambusæ*. Only the last two were originally described from Sandwich Island specimens.

From Tasmania we know a few species in *Monophlebus illigeri*, *Aspidiotus acaciæ*, and *Mytilaspis pomorum*, the last, of course, introduced. There are probably some other Tasmanian records, as I have not so far made any great effort to distinguish them from those pertaining to Australia.

The number of known species from Australia and New Zealand, exclusive of those introduced from other countries, is shown in the following table:

Summary of native species from Australia and New Zealand.

Genus.	Number of species.		Genus.	Number of species.	
	Australia.	New Zealand.		Australia.	New Zealand.
Cœlostoma	3	5	Icerya	3	.....
Palæococcus	.....	1	Eriococcus	9	8
Gossyparia	2	1	Callipappus	1	.....
Rhizococcus	[1]3	6	Rhizœcus	[3]1	.....
Solenophora	.....	2	Phenacoccus	2	1
Dactylopius	9	8	Kermes	1	.....
Ripersia	1	3	Asterolecanium	1	1
Prosopophora	2	.....	Brachyscelis	13	.....
Tachardia	3	.....	Ascelis	[4]1	.....
Opiothoscelis	2	.....	Sphærococcus	7	.....
Frenchia	1	.....	Signoretia	1	.....
Cylindrococcus	3	.....	Pulvinaria	[5]4	.....
Eriochiton	.....	2	Lecanaochiton	.....	2
Ctenochiton	.....	11	Ceroplastes	2	.....
Inglisia	1	5	Aspidiotus	9	4
Lecanium	3	1	Parlatoria	2	.....
Diaspis	1	1	Chionaspis	3	[6]2
Mytilaspis	7	8	Fiorinia	3	4
Leucaspis	1	.....			
Poliaspis	1	1	Total[7]	108	77
Monophlebus	[2]2	.....			

[1]One variety is recognized.
[2]Two additional varieties are recognized.
[3]On a palm introduced from New South Wales.
[4]Another described by Pepper, is really a psyllid.
[5]One variety is recognized.
[6]Counting *C. minor*, which may not be native of New Zealand, the number is increased to three.
[7]The native species of the two countries being in every case except one distinct, we have a total of 184 species for the two islands.

The description of the New Zealand species has been entirely the work of Mr. Maskell; and except in the Brachyscelidæ, which have been discussed by Schrader, Froggatt, and Tepper, he has described nearly all the Australian species. The exceptions are a *Diaspis* described by Tryon, a *Ceroplastes* (unrecognizable) by Walker, *Callipappus* of Guérin-Méneville, *Coccus blanchardi* (*see* Signoret's work), and *Pulvinaria maskelli* of Olliff. The *Rhizœcus* was described in 1878 by Künckel d'Herculais.

The late Mr. Frazer S. Crawford had collected a number of Australian Coccidæ, and had given them manuscript names, but his death came before he could attempt publication. These species were afterwards described by Mr. Maskell, who duly cited Crawford's manuscript names.

In this connection, Mr. Koebele's very successful second trip to Australia should not be forgotten, as showing what may be done by a good collector. In the Transactions of New Zealand Institute for 1892 Mr. Maskell describes the following new species, all collected in Australia by Mr. Koebele:

Diaspis fimbriata, Mytilaspis casuarinæ, Fiorinia syncarpiæ, Ceroplastes rubens, Lecanium scrobiculatum, Prosopophora eucalypti, Gossyparia casuarinæ, G. confluens, Eriococcus turgipes, E. conspersus, Pseudococcus

nivalis, *Cœlostoma rubiginosum* (also found by Mr. French), *Monophlebus fuscus*, *Icerya koebelei*, *Carteria decorella* (also found by Mr. Olliff). Total, 15 species.

NEOTROPICAL REGION.

I have given a list of the neotropical Coccidæ in the Journal of the Trinidad Field-Naturalists' Club for 1894. Previously, in the Journal of the Institute of Jamaica, a list of the West Indian species had appeared.

Dactylopius calceolariæ, Maskell was accidentally omitted from the first-mentioned list; it is from Jamaica, not Mexico, as stated by Mr. Maskell.* *Aspidiotus bowreyi*, Cockerell, *Ceroplastes albolineatus*, Cockerell, *Lecanium urichi*, Cockerell, *Margarodes vitium*, Giard (=*vitis*, Phillippi, sub. *Heterodera*), *Aspidiotus latastei*, Cockerell, and *Mytilaspis philococcus*, Cockerell, have been described since the list was written; the first two are from Jamaica, the third from Trinidad, the fourth and fifth from Chile, and the last from Mexico.

Thus, all told, the neotropical list now stands at 124.

Anyone consulting the above-mentioned lists will see how very few species are known from the mainland countries, with the exception of British Guiana and Mexico, and even for these the lists are extremely small in comparison to the presumably existing numbers. From Ecuador we know only the one (*Ortonia uhleri*) found by Prof. Orton when crossing the desert of Napo. This discovery was made on November 7, 1867, the locality being 6,600 feet above sea level.† From Guatemala we know only one; from Peru apparently none; from Colombia only *Icerya montserratensis* at Colon.‡

From the Argentine only *Palæococcus brasiliensis* (Walker), found at Buenos Ayres. From Uruguay a couple of species found at Montevideo. From Paraguay and Bolivia none; from Brazil about half a dozen.

From Chile we knew nothing except the now lost *Ceroplastes chilensis* of Gray, and a few introduced forms; but Mr. Lataste has become interested, with the resulting discovery of two new species, mentioned above.

From Trinidad we now know quite a number of species, mostly collected by Mr. Urich.

Regarding the West Indian Islands I have already made some remarks in Insect Life, VI, p. 100. From the Cayman Islands, we know *Diaspis lanatus* and *Chionaspis minor* from Grand Cayman, collected by H. MacDermot.

No addition has been made to the small list for Cuba, and Haiti is

* Trans. New Zeal. Inst. for 1893, p. 89.

† I have not here entered upon the question of the vertical distribution of Coccidæ, the data being wholly insufficient. But I suppose that *Orthezia occidentalis* and *Pulvinaria bigeloviæ*, from about 7,800 feet in Colorado, represent the highest Coccidæ so far known.

‡ Insect Life, 1894, p. 327.

still without a record. In the Lesser Antilles we have one or two additional records due to Mr. Barber; thus Dominica now has two instead of one, Montserrat six instead of four. Martinique has a record of *Diaspis lanatus* (Insect Life, VII, p. 288). Puerto Rico still seems to be without a record.

The recent visits to the West Indies of Dr. Riley and of Mr. Hubbard who gave special attention to Coccidæ, will no doubt in due time lead to many new records, for which we must wait until the material can be worked over.

There now remains Mexico, which I will for convenience treat as a whole, although parts of it are hardly neotropical. Until recently (and now, so far as published records go) the Mexican list stood at 28, having gradually attained that figure in the following manner:

Species known before Signoret's "Essai" (1818-1868)	
Species added by Signoret in his "Essai" (1869-1876)	3
Species added by Comstock (1883)	2
Species added by Riley and Howard in Insect Life	3
Species found by Dr. A. Dugès (1886-1894)	5
Species found by the present writer on journey through Mexico in 1893	12
Total	28

Having in view this deplorable want of information as to Mexican Coccidæ, the Department of Agriculture lately sent Prof. C. H. T. Townsend into that country to collect these and other insects. I examined the Coccidæ collected, and may remark that they add considerably to our knowledge; but beyond this, I do not now feel at liberty to go, since they are the property of the Entomological Division, which has the right of first announcing the discoveries made.

NEARCTIC REGION.

A catalogue of the nearctic species has appeared in the Canadian Entomologist for February, 1894, and I understand that Mr. Ashmead has in press a complete bibliographical list of all nearctic Heteroptera and Homoptera, including also those of the northern portion of the neotropical region.

In the Canadian Entomologist's list, I was so unfortunate as to accidentally omit *Dactylopius ephedræ*, Coquillett, 1890, *Lecanium tarsale*, Signoret, 1873, and *Orthezia cataphracta*, Shaw (*Chiton*, Zetterstedt). The last mentioned has, according to Hart, been found in Greenland, as well as in Ireland and Scotland.

Furthermore, since my list appeared, it has been shown that *Aspidiotus convexus* is not a valid species, and that *A. abietis* and *A. pini* are synonyms of *A. abietis* (Schrank) of Europe. I do not think Mr. Pettit's manuscript *A. abietoides* can be any better distinguished from *abietis*, and until he sets forth some reasons for maintaining its validity, it had better be left out of account. Riley's manuscript *A. corticalis* must also be dropped until we are informed what specific characters it exhibits; likewise his *Ceroplastes artemisiæ*. *Lecaniodiaspis yuccæ* can

stand on the basis of Prof. Townsend's description, which, though short and informal, serves to distinguish it from anything else yet known.

Since the Canadian Entomologist's list appeared, the following species have been added: *Eriococcus coccineus*, Cockerell (with form *lutescens*, Cockerell), from Nebraska, *Lecanium phoradendri*, Cockerell, from Arizona; *L. insignicolla*, Crawford (should be *insignicola*), from California; *Ceroplastodes daleæ*, Cockerell, from New Mexico; *Tachardia cornuta*, Cockerell, from New Mexico; *Dactylopius solani*, Cockerell, from New Mexico; *Bergrothia steelii*, Cockerell and Townsend, from New Mexico; *Diaspis lanatus*, Morgan and Cockerell, introduced in Florida and District of Columbia, also in Georgia; *Diaspis amygdali*, Tryon, introduced in California.* There have also been added two varieties (var. *pruni*, Cockerell and var. *albus*, Cockerell) of *Aspidiotus juglans-regiæ*. The description of a very interesting *Ripersia*, the first of its genus for our region, awaits publication.

With the above changes and leaving out the fossil species, the nearctic list now stands at 127. But if we exclude from it those species believed to have been introduced by man it is reduced to 94 or even less.

Examining the list from a historical standpoint, we see that practically nothing had been done up to the time of Fitch. About 10 of the Fitch species are now considered valid, but some of those in *Lecanium* are even now very imperfectly known. From Fitch to Comstock (1860–1880), that is, over a period of about twenty years, next to no progress was made, and the few descriptions that appeared were singularly imperfect. Prof. Comstock put the matter on a totally different basis. When he commenced his studies the coccidology of North America was in about as chaotic a condition as could be imagined; when he left off in 1883 our knowledge, at least of the Diaspinæ, had increased enormously. No less than 29 valid species are now credited to Comstock.

One might have supposed that after this revival many new students would have come forward; but from 1883 to 1893 was again a period of comparative stagnation, although we have isolated descriptions at the hands of Coquillett, Douglas, Riley and Howard, and Crawford. Nevertheless, during this period, the life histories and parasites of several species were elucidated, and almost every number of Insect Life has contained some new information.

At length in the present year, 1894, more is being done, and in many places work is going on, which should, soon lead to valuable results. Students have arisen in California, Illinois, Michigan, Massachusetts, and New York, while others in Colorado, Arizona, Nebraska, etc., have been on the lookout for material, though their studies did not include the Coccidæ.

NEW MEXICO AGRICULTURAL EXPERIMENT STATION,
Las Cruces, New Mexico, Oct. 27, 1894.

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* Insect Life, VI, p. 290.

DESCRIPTION OF A NEW SPECIES OF ROCKFISH, SEBASTICHTHYS BREVISPINIS, FROM ALASKA.

By Tarleton H. Bean, M. D.,
Curator of the Department of Fishes.

In 1882 Capt. Henry E. Nichols, of the U. S. Navy, made a collection of fishes in Alaska and British Columbia for the U. S. National Museum. A catalogue of the species obtained by him was published in these Proceedings,* and among the number is a rockfish (No. 32004, U.S.N.M.) from Hassler Harbor. In the catalogue referred to the species was named "*Sebastichthys proriger*, Jordan and Gilbert, subspecies *brevispinis*, nov." After comparison with *S. proriger* it was found to differ from that form in having the peritoneum white and the second anal spine shorter than the third.

The next notice of the fish was published by Dr. D. S. Jordan in 1884.† In that notice it was mentioned as a distinct species, with reference to the differential characters first brought to notice by the present writer.

This species is fully distinguished from *S. proriger* and other known forms of the genus, and may be characterized as follows:

SEBASTICHTHYS BREVISPINIS, Bean.

Sebastichthys proriger subspecies *brevispinis*, Bean, Proc. U. S. Nat. Mus., vi, p. 359, 1883.

The type of the species is No. 32004, U.S.N.M., the specimen being 370 millimeters (14½ inches) in length, including the caudal fin.

In spirits the back is pale rusty brown; the sides below the lateral line are paler; the belly is whitish. Traces of dark color on the membrane of the spinous dorsal; the soft dorsal, pectorals, ventrals, and anal pale. Some traces of brownish on the caudal membranes.

Body elongate, compressed, its greatest height two-sevenths of the length without caudal; its greatest width one-third length of head. The caudal peduncle is short, its least depth five-sixths of its length from end of soft dorsal to base of middle caudal rays. The head is similar to that of *S. proriger* in shape, its length being contained two and two-thirds times in total without caudal.

* Proc. U. S. Nat. Mus., vi, 1883, pp. 353-361.

† Rept. U. S. Commr. of Fish and Fisheries, 1884, p. 107.

Cranial ridges almost obsolete, except on the occiput, where the spines are long and depressed, nearly as long as the eye. Preocular and supraocular spines present; no tympanic spines.

Mouth large, the broadly expanded maxillary reaching beyond the middle of the eye. The length of the upper jaw (intermaxilla and maxilla) almost one half length of head. The lower jaw much projecting, its length equaling that of eye and postorbital part of head. The upper half of the maxilla is covered with very fine scales; the mandible also has fine scales along its middle and posterior portions. The mandible has a well-developed knob at the symphysis. The eye is three-fourths as long as the snout, rather more than one-fifth the length of the head, and about equal to the width of the nearly flat interorbital space. The width of the preorbital is less than one-half the length of the eye. The preopercular spines are short and sharp; the second longest, about one-third as long as the eye; the first, fourth, and fifth very small; the points of the fourth and fifth are directed obliquely downward and backward. The gillrakers are moderately long and slender; eleven above and twenty-three below the angle, the longest at the angle one-half as long as the snout or two-thirds as long as the eye. The scales are small—eighty-six or eighty-seven rows in a longitudinal series, only fifty-one of which are pierced by tubes.

The spinous dorsal is low, the first spine two thirds as long as the second and rather more than two-thirds as long as the eye; the fourth to the sixth spines longest, rather more than one-third length of head. The membrane of the soft dorsal and to some extent that of the spinous dorsal scaly. The longest soft ray of the dorsal is rather shorter than the longest spine; the last soft ray is as long as the first spine. The first anal spine is very short, two-fifths as long as the second, or one-half as long as the eye; the second spine is shorter and stouter than the third, equal to the snout in length; the third spine is nearly one and one-half times as long as the eye. The longest soft ray exceeds the length of the longest dorsal spine and is nearly equal to the postorbital part of the head. The pectorals are shaped very much as in *S. proriger;* the lower four or five rays are slightly exserted at the ends; the middle rays longest, slightly longer than the head without the postorbital part. The ventrals do not extend as far back as the pectorals; their distance from the vent equal to half their own length, which is two-fifths the length of head. Peritoneum silvery white.

D. XIII, 14; A. III, 7.

In *S. proriger* the second anal spine is distinctly longer than the third; the peritoneum is black; a tympanic spine is present; the gillrakers 40 in number and many of them club shaped at the end, the longest rather more than one-half the length of the eye; the fourth and fifth preopercular spines are directed horizontally backward, and the scales are in seventy-five rows. These comparisons are drawn from the type of *S. proriger*, No. 26980, U.S.N.M.

DESCRIPTION OF A NEW SPECIES OF FISH, BLEEKERIA GILLI.

By TARLETON H. BEAN, M. D.,
Curator of the Department of Fishes.

THIS SPECIES of sand-lance is described from eleven examples belonging to the U. S. National Museum. The locality is doubtful, the data being lost, but it is probable that they belong to Dr. Stimpson's collections from the Pacific. The largest example is five inches long, the smallest three inches.

BLEEKERIA GILLI, new species.

Diagnosis.—D. 47; A. 22 to 24; P. 15. Scales 97, of which 90 are in the lateral line; transverse rows 3 to 14. The scales are regularly imbricated and the skin is entirely without longitudinal folds. The lateral line is wanting on the last six or seven scales; it ascends abruptly over the pectoral and follows not far from the dorsal outline, terminating between the end of the dorsal and the origin of the caudal.

Gill-rakers numerous, smooth along posterior margin, long and slender, the longest about as long as the eye. Branchiostegals 7. Pseudobranchiæ large, about 20 laminæ. The pectoral reaches to the thirteenth row of scales, its length equal to length of eye and snout combined. The maxilla extends to below the front of the eye; intermaxilla very protractile, forming about two-thirds of the length of upper jaw. Labial fold of mandible well developed. Head naked. Dorsal and anal received in a deep sheath. A small, thin, ovate flap between the anal and the genital opening, this flap covering the latter opening.

Eye large, one-fifth of head, greater than interorbital space. Tip of preoperculum produced into a short, triangular flap. Suboperculum with three well-defined radiating striæ. Angle of preoperculum with several raised tubular ridges. Many of the scales, especially posteriorly, with coarse denticulations around the exposed margin. Head one-fourth of total length without caudal; greatest depth one-half head, nearly one-eighth of the standard body length. The distance of the dorsal origin from the tip of snout nearly equals the length of the

head. Vent a little nearer root of caudal than to origin of pectoral. Caudal forked; the middle rays nearly two-thirds as long as the outer.

Back grayish brown; sides and lower parts silvery. General appearance of *Ammodytes*.

Type.—No. 45384, U.S.N.M.

The species is dedicated to Dr. Theodore Gill, thereby associating the names of two eminent ichthyologists, whose contributions to this branch of zoology have in many respects followed along similar lines.

DESCRIPTION OF GOBIOIDES BROUSSONETI, A FISH NEW TO NORTH AMERICA, FROM THE GULF OF MEXICO.

By Tarleton H. Bean and Barton A. Bean.

This species, originally described by Lacépède from Peru, and afterwards obtained by Brevoort from Para, South America, is now for the first time recorded from North America. The species can not be referred to the genus *Amblyopus*, which has for its type the *A. hermannianus* of Lacépède. The latter has rudimentary eyes, a short body, and the dorsal and anal many rayed.

Diagnosis.—D. VI, 17; A. I, 16.—The total length of the specimen is 14½ inches, the caudal fin being 2¾ inches long.

The greatest depth of the body (see fig. 1) equals one-half the length of the head, and is contained fourteen times in the total length without caudal. The greatest depth of the head equals the length of the upper jaw, or about one-half the length of head without snout. The body is compressed. Its greatest thickness is contained one and two-thirds times in its greatest depth. The teeth are in narrow bands in each jaw,

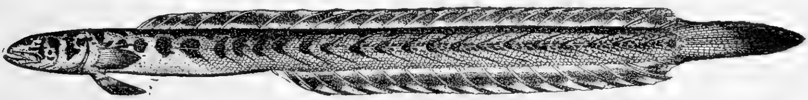

Fig. 1.

GOBIOIDES BROUSSONETI.

About two-sevenths natural size.

some of those in the outer row enlarged, canine like, and curved inward. All of the teeth are more or less curved inward and depressible. The vomer and palate are toothless. The mouth is oblique, the lower jaw projecting slightly beyond the upper. The maxilla extends well behind the eye; its length is slightly more than half that of head without the snout. It is not much expanded posteriorly. Eyes very small, their diameter equaling half length of snout, about equal to width of interorbital space. The snout scarcely equals more than a fifth of the head's length. Gill openings wide, the membranes wholly joined to the isthmus.

Branchiostegals much curved, four in number. The dorsal begins at a distance from the nape equal to the postorbital part of the head, the origin being about over the end of the extended pectoral. The ventral reaches farther back than the pectoral, and is longer than that fin, its length equaling postorbital part of head. The distance of the vent from the tip of the snout equals somewhat more than three times the length of the head; it is under the interspace between the last spine and first ray of the dorsal, with a small genital papilla behind it. The caudal is very long and tapering, one and two-thirds times as long as the head. The dorsal spines are long and slender, the fifth nearly as long as the post-orbital part of the head. The second dorsal ray is slightly longer. The anal rays are about as long as those of the dorsal. The scales are thin, not imbricated, except on the posterior part of the head, where they are long and elliptical in shape. The head and breast are naked.

Color.—The colors have faded out in alcohol; the ground color appears to have been light brown, with darker blotches on the median line of the body under the spinous portion of the dorsal and the anterior part of the soft dorsal.

The specimen here described was obtained in the Gulf of Mexico and presented to the Museum by Mr. Robert S. Day, of New Orleans, La. It was received June 30, 1885, and is No. 38220, U. S. National Museum.

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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No. XXXIII.—DESCRIPTIONS OF TWO NEW FLOUNDERS, GASTROPSETTA FRONTALIS AND CYCLOPSETTA CHITTENDENI.

By BARTON A. BEAN,
Assistant Curator of the Department of Fishes.

THE U. S. Fish Commission steamer *Albatross* obtained on January 15, 1885, at station 2317, lat. 24° 25′ 45″ N., long. 81° 46′ 45″ W., being near Key West, Fla., in 45 fathoms of water, two specimens of a handsome flounder, which appears to be new. The larger example, the subject of the illustration (fig. 1), is eight inches long, while the smaller one slightly exceeds six inches. A still larger specimen was obtained near Apalachicola, at station 2373.

GASTROPSETTA, new genus.

This genus is closely allied to *Ancylopsetta*, from which it differs in form of body, and also in having entirely smooth scales, singularly branched and produced anterior dorsal rays, and very short and broad gill-rakers.

Diagnosis.—Body oblong-ovate, highly arched in front, covered with small, cycloid, imbedded scales; lateral line arched in front, deflected downward on caudal peduncle. Teeth small, in a single series in each jaw. Dorsal fin beginning in advance of eye, its anterior rays produced, not connected by the irregular and broadly fringed membrane. Gill rakers very short, almost as broad as long, few in number. Ventral of eyed side produced, ending in a long filamentous ray in the young.

GASTROPSETTA FRONTALIS, new species.

Diagnosis.—Length of specimen, 209 mm.; depth, 80 mm.; head, 44 mm.; middle caudal rays, 38 mm.; D. 60; A. 48; V. 6; P. I, 10. Eyes large, $3\frac{3}{4}$ in head; mouth of moderate size, maxilla $2\frac{1}{2}$ in head, the jaws curved; interorbital ridge prominent, very narrow. The dorsal begins in front of eye on snout, its anterior rays singularly branched, the third and fourth longest, almost equaling length of head. Anal fin beginning at

vent, which is situated on blind side, its anterior rays scarcely produced. Ventral of colored side much produced. Middle caudal rays long.

Color in spirits light brown; three black spots on body, two along back, and one near anal base; fins with dusky blotches; several vertical stripes across eyes.

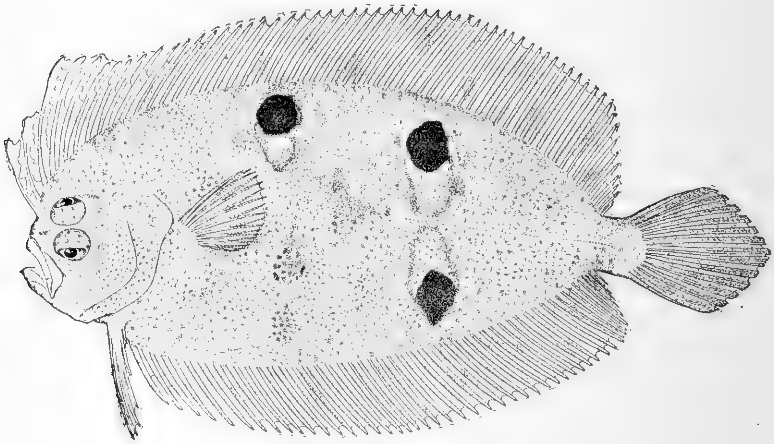


Fig. 1.

GASTROPSETTA FRONTALIS.

About one-half natural size.

The smaller specimen from station 2317 has D. 62; A. 52; V. 6; P. I, 11. The gill-rakers short, broad laminæ, 2+7. Teeth weak, uniserial. Anterior rays of dorsal greatly produced, the third being one and one-half times as long as the head. Ventral of eyed side very long, ending in a thread-like filament. Color as in the preceding.

The example from station 2373 is 224 mm. long; its depth, 90 mm. The ray formula is as follows: D. 60; A. 49; P. I, 10; V. 6; C. 15. The vent is situated in a deep notch, which forms the front margin of the abdomen, and not on the side, as in the other specimens. The color is darker than that of the Key West examples, being dark reddish-brown. Body spotted and fins blotched as in the preceding.

Type.—No. 37668, U.S.N.M.

Genus CYCLOPSETTA, Gill.

In the eleventh volume of these Proceedings* Dr. Gill gives the following diagnosis of a new genus of flounders, which he names *Cyclopsetta:*

Psettines with the body oblong rhombo-ovate, covered with regularly imbricated moderate cycloid scales; lateral line nearly rectilinear on both sides; snout convex;

* Proc. U. S. Nat. Mus., XI, 1889, p. 601.

mouth very large; jaws squarely truncated behind; teeth uniserial, those of the upper jaws moderate, of lower jaws enlarged and largest at sides; dorsal and anal almost symmetrical, dorsal commences in front of eye on snout, scarcely deflected on blind side; caudal slightly pedunculate and convex; pectorals subequal and with a subtruncate free margin; ventral nearly equal, the left on the preanal ridge, the right lateral, both with the inner rays connected by membrane to the body; interbranchial membrane imperforate; gill-rakers tubercular and surmounted by blunt denticles.

Type *C. fimbriata* The scales on the eyed side are regularly cycloid with the nucleus some distance from the posterior margin and with numerous radiating striæ. The gill rakers are quite characteristic.

The species about to be described is distinguished from the type of the genus by its shorter head, smaller and closely adhering scales, larger teeth, the little-produced anterior dorsal rays, and by the oblique posterior margin of the pectorals.

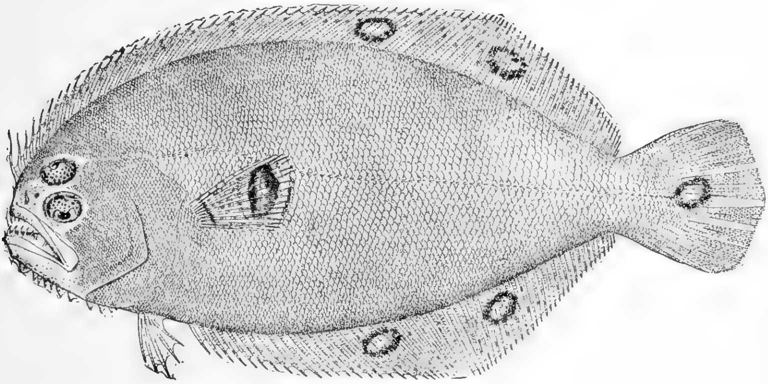


Fig. 2.

CYCLOPSETTA FIMBRIATA.

About two-fifths natural size.

In *C. fimbriata* the scales are rather large and deciduous, the teeth small, the anterior rays of the dorsal considerably produced, and the posterior margin of the pectoral is subtruncate. It has been thought well to publish a drawing of the type of the genus (see fig. 2) in this paper.

CYCLOPSETTA CHITTENDENI, new species.

On April 4, 1892, the Museum received from Dr. John F. Chittenden, of the Victoria Institute, Port of Spain, Trinidad Island, a single specimen of the species here described as new and named in his honor.

Diagnosis.—A single specimen. Extreme length, 197 mm. ($7\frac{3}{4}$ inches.) Greatest depth of body, not including vertical fins, 76 mm. (3 inches.) D. 82; A. 62. Scales ca., 90. Gill-rakers 8+3 to 4, very short, tubercular, almost as broad as long.

The length of the head is contained three and one-half times in that of the body, and the depth of the body two and one-fifth times in its length, without caudal. The diameter of the eye is contained five times in the head's length. The mouth is widely cleft, oblique, the jaws curved. The cleft of the mouth is contained less than twice in the length of head. The teeth of both jaws in a single series, those of the lower jaw are strong and sharp, curved inward and backward; those of the upper jaw are not so large, and are very irregular in size.

The ventral fins are well developed, that of the eyed side being on the abdominal ridge, and about three-fourths as long as the pectoral. The pectorals are half as long as the head, their length equalling a little more than one-third of the body depth; posterior margin oblique.

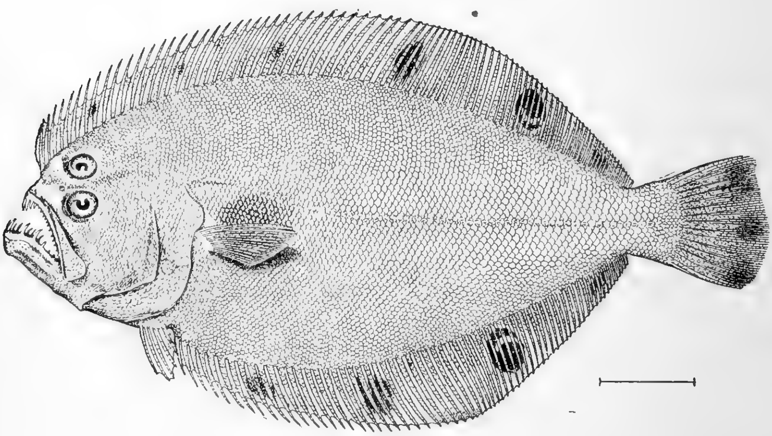


Fig. 3.

CYCLOPSETTA CHITTENDENI.

About one-half natural size.

Color brown; fins lighter, marked with blackish. Three small faint blotches of black on the first half of the dorsal fin, and three rather distinct blotches on the second half, the last blotch extending to the caudal peduncle. Anal fin with three black blotches situated as and similar to those of the dorsal fin. The ventral of the eyed side is blackish, that of the blind side pale. Caudal fin with three black spots at its extremity. Pectoral fin of colored side blackish; quite a large blotch of black on body under this fin.

Type.—No. 44100, U.S.N.M.

NOTES ON SOME ERUPTIVE ROCKS FROM GALLATIN, JEFFERSON, AND MADISON COUNTIES, MONTANA.

By George P. Merrill,
Curator of the Department of Geology.

The rocks described below were collected by Dr. A. C. Peale and the writer, mainly during the seasons of 1887, 1888, and 1889. The writer's own observations were limited to two brief seasons in 1887 and 1889. The region covered is quite extensive, comprising upward of 200 square miles as shown on the Three Forks sheet of the U. S. Geological Survey, and much of it difficult of access. In many instances doubtful points regarding the occurrence and association of certain masses could have been decided only by a second visit to the locality, after the first series of specimens collected had been submitted to study in the laboratory and we were in a condition to avail ourselves of the knowledge thus gained. Unfortunately, this we have been unable to do, and while in many instances we are led to infer that somewhat variable rock types are but widely separated facies of the same magma, we have no absolute proof of the same. Eruptive rocks of a wide geological range and of widely varying character are abundant throughout the region. Here I shall attempt to describe only those of greatest petrological interest. A few of them have been noted in a preliminary way in Bulletin No. 110, U. S. Geological Survey, 1894.

In describing the rocks they will be taken up as found along the main routes traveled, in the following order: (1) From the foothills north of Gallatin Peak, along the valley of the Gallatin and East Gallatin to the Horse Shoe Bend of the Missouri River; (2) from Three Forks southward, up the Madison Valley and into the foothills on either side as far as the Wedge and westward to Virginia City; (3) from the same point, southwestward, up the Jefferson River as far as South Boulder Creek. The numbers referring to specimens are those given in the catalogues of the U. S. National Museum.

Enstatite andesite.—Head of small creek west of Salesville, west side of Gallatin River. A dense, dark-brownish, nearly black rock, without macroscopic constituents of such dimensions as to be evident to the unaided eye. In thin sections, a dense, partially devitrified base filled with opaque granules of iron ore, pyroxene, and feldspar microlites, and carrying abundant small elongated phenocrysts of nearly colorless pyroxenes. These without evident pleochroism, and orthorhombic in crystallization. Hence, doubtless, enstatite. Rarely small augites occur. In a few instances the latter mineral occurs in the form of a narrow zone about the enstatites, as described by Iddings.* The feldspathic constituents are confined wholly to microscopic forms in the ground mass.

Basalt (?).—Small outcrop in Cretaceous, some 2½ miles southeast from Bozeman, east side of Bozeman Creek.

Macroscopically the rock (No. 38598, U.S.N.M.) is compact, dull, dark-green, almost black, thickly studded with rounded olivine in sizes up to 5mm. in greatest diameter, and numerous smaller green augites; none of these porphyritic constituents are prominently noticeable, owing to the similarity of their colors to that of the rock containing them. A chloritic alteration has set in, attacking both the minerals mentioned as well as the groundmass, and this, together with the other features mentioned, imparts to the stone the appearance of an olivine rich peridotite in which the process of serpentinization has far advanced. The olivines in alteration have sometimes given rise to deep red ferruginous products which are visible to the unaided eye.

As viewed in the thin section and by ordinary light the rock consists of a clear, colorless, groundmass with an illy defined radiate structure, often pierced in every direction by innumerable minute needle-like colorless forms, and bearing abundant black granules of iron oxides, through which are interspersed countless small, idiomorphic, very light-greenish pyroxenes. Abundantly distributed throughout this groundmass are the larger olivines and less abundant augites already noted. A chloritic alteration has set in, attacking the augites, olivines, and colorless groundmass alike, though the augites are the least attacked. The most striking feature of the rock is this colorless groundmass, which appears under a low power (80 diameters) and between crossed nicols, as illy defined fan-shaped aggregates of elongated crystals, over which the dark wave sweeps gradually as the stage is revolved. There is apparently little, if any, true amorphous, glassy, or felsitic base, or microlitic matter. The field, on the contrary, between crossed nicols, breaks up into somewhat illy defined polygonal areas, which become light and dark as the stage is revolved, but in no case give satisfactory extinction angles or interference figures. The structure, in short, is that of an imperfect radial spherulitic aggregate, such as is common

* Eruptive Rocks of Electric Peak and Sepulchre Mountain. Ann. Rep. U. S. Geol. Survey, 1890–'91.

in the quartz porphyries and liparites, but such as I have never seen in rocks so basic in composition as is this.

Under a power of 390 diameters the individual columns of the aggregate were found in some instances to be almost wholly without action or polarized light, or again polarized in light and dark colors, some of the better defined giving extinctions parallel with or ranging but a few degrees from the axis of greatest elongation, and eminently suggestive of feldspars; in a few instances indefinite interference figures were obtained, but only such as might be due to tensile strain on isometric or amorphous bodies.

The results of purely optical investigation proving thus unsatisfactory, an attempt was made at a separation of the mineral by pulverization and precipitation in the iodide of mercury and potash solution.

This proved a work of great difficulty, owing to inclusions of iron ore and the chloritic alteration which had set in. After repeated attempts a powder coming down at a density of 2.56 was obtained in sufficient quantity for analysis. This yielded Mr. Eakins, of the U. S. Geological Survey, results as follows:

	Per cent.	Ratio.
SiO_2	65.23	1.02
Al_2O_3	17.48	.17
Fe_2O_3	.98	....
CaO	3.08	.05
MgO	2.02	.05
K_2O	4.63	.05
Na_2O	3.79	.06
H_2O	1.90	.11

Such a composition is evidently that of a mixture, and may perhaps be explained on the assumption that it consists of two feldspars (sanidin and a soda-lime variety) and an aluminous pyroxene.

The pyroxenic constituent, as above noted, occurs both in porphyritic forms and as a constituent of the groundmass, sometimes in good idiomorphic forms and again as rounded and irregular granules scattered singly and in clustered aggregates. Except in the matter of size the individuals of the two generations are indistinguishable from one another, are of a light greenish color, not noticeably pleochroic, and give extinction angles on clinopinacoidal sections as high as 41°. The larger porphyritic forms are sometimes 3 or 4 mm. in diameter, while those of the groundmass are, as a rule, not over 0.05 mm., and at times sink to 0.02 mm.

By pulverization and separation by the iodide of mercury and potash solution, and subsequent digestion in hydrochloric acid and potassic carbonate, a sufficient supply of the pryoxenic constituent was obtained for a complete analysis. This, submitted to Mr. Eakins, yielded results as given in column I, below. In columns II, III, and IV are given for

comparison, chrome diopsides out of the peridotites of (II) Lake of Lherz, (III) Dillgegend, and (IV) Piedmont, as given by Teall.*

	I.	II.	III.	IV.
SiO_2	52.50	53.63	50.443	54.25
Al_2O_3	2.26	4.07	5.105	6.07
Cr_2O_3	1.07	1.30	1.403	1.48
Fe_2O_3	2.05	} 8.50	9.696	7.49
FeO	2.47			
MnO	Trace.	....	....	....
CaO	21.70	20.37	14.629	17.75
MgO	17.11	12.48	17.418	13.63
K_2O	.07	....	....	....
Na_2O	.35	....	....	....
H_2O	.64	....	....	....
	100.22	100.35	98.694	100.67

A bulk analysis of the rock yielded Dr. Chatard as follows:

	Per cent.		Per cent.
SiO_2	46.90	MgO	20.98
TiO_2	0.41	K_2O	2.04
P_2O_5	0.44	Na_2O	1.16
Al_2O_3	10.17	H_2O at 120° C.	1.04
Cr_2O_3	0.33	H_2O at red heat	4.38
Fe_2O_3	1.22		
FeO	5.17		100.54
MnO	0.10	Specific gravity	2.86
CaO	6.20		

The composition, as above indicated, is quite unlike that of any rock I have yet seen described. So far as indicated by the silica percentage, the rock might belong to the diabase or basalt group, but the magnesia percentage is far higher than I have ever seen reported in rocks of this class, and from either of which it differs structurally. It is equally difficult to consider the rock a peridotite, since not only is the silica percentage above that of a normal peridotite, but the high percentage of potash and soda (confined wholly to the minerals of the groundmass) indicate a very considerable quantity of sanidin and soda-lime feldspar.

To gain a further insight into the composition of the rock, fragments from the same mass as that used in the above bulk analysis were subsequently sent to the laboratory with the request that an analysis be made of that portion soluble in hydrochloric acid. The results are given below.

Amount of rock soluble in HCL 48.7191 per cent. This yielded:

	Per cent.	Ratio.	
SiO_2	42.87	....	.714
Al_2O_3	7.98	.077 }	.105
Fe_2O_3	4.53	.028 }	
FeO	8.78	.122 }	1.001
MnO	Trace.	......	
CaO	2.07	.037	
MgO	33.69	.842 }	
Alkalies	Trace.	....	
	99.92		

*British Petrography, p. 89.

It is evident that this is essentially olivine with a mixture of iron oxides and decomposition products.

In the summer of 1889, while working on Bear Creek, in the foothills just east of and overlooking the Madison Valley, some 45 miles in a direct line to the southwest, inconspicuous outcrops of an intrusive were discovered, which were at once seen to be nearly identical. On returning to Washington thin sections were prepared, from an examination of which the first impressions were abundantly confirmed. Certain of the slides were indistinguishable from those of the Fort Ellis rock; others differ in showing a groundmass more crystalline and a somewhat smaller proportion of the porphyritic olivines. The base proper is here a nearly colorless glass occurring only in the interstices of a crowd of small, lath-shaped feldspars, mainly a plagioclase variety, though certain nonstriated forms may be sanidin.

Throughout this groundmass are scattered innumerable black granules of iron ore and the olivines and augites as already described. The rock has an aspect more nearly like that of normal basalt, but differs in the character of its pyroxenic constituent and the abundance of its olivines. A bulk analysis of the rock by Dr. Chatard yielded results as in I below. II is the Fort Ellis rock reproduced for the purposes of comparison.

	I.	II.		I.	II.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
SiO_2	49.13	46.90	CaO	5.68	6.20
TiO_2	.42	.41	MgO	17.21	20.98
P_2O_5	.38	.44	K_2O	2.24	2.04
Al_2O_3	9.05	10.17	Na_2O	2.01	1.16
Cr_2O_3	.39	33	BaO	.05	....
Fe_2O_3	3.57	1.22	H_2O at 110° C	.84	1.04
FeO	5.05	5.17	Ignition	3.50	4.38
MnO	.15	.10			

The close relationship of this rock to the dark eruptive between South Boulder and Antelope Creek is mentioned on page 673.

Augite andesite.—Hills east of Fort Ellis. As here displayed, this is a coarse, dark-gray rock (No. 38597, U.S.N.M.), full of vesicles and amygdules of all sizes up to an inch or more in diameter. Its only macroscopic constituent, aside from the secondary minerals comprising the amygdules, is a dark-greenish augite which occurs as scattering crystals, at times four or five millimeters in diameter.

Under the microscope the rock presents an exceedingly dense microlitic groundmass of lath-shaped plagioclases, augites and iron oxides in which are embedded widely-scattered porphyritic plagioclases, and more numerous augites with an occasional dusky apatite. The augites, although comparatively fresh appearing, are rarely in well-developed crystals, but occur as very irregularly corroded and rounded forms full of inclosures of the base and of magnetite particles. In the

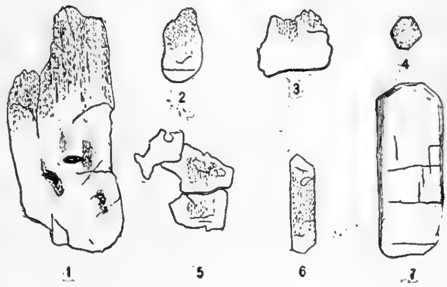
section they are of a light-greenish color. The porphyritic plagioclases are small and widely scattered.

As already noted, the rock is quite vesicular, the vesicles being wholly or in part filled by white, dull red, and greenish zeolites. There is also a smoky-brown, undetermined mineral which occurs only as a narrow border of minute radiating fibers projecting inward from the cavity wall and visible only with the microscope. The white mineral is by far the most abundant of all the secondary constituents. When viewed in the section and between crossed nicols this is in some cases quite isotropic, and in others polarizes faintly in dull colors, the field being divided into polygonal areas over which the shadows play, alternately as the stage is revolved. The appearance is such as to suggest at once the anomalous analcite described by Ben-Saude,* although in the present case the optical peculiarities are less pronounced. An examination of the hand specimen reveals in the larger cavities many small, nearly colorless trapezohedra of the mineral which have a specific gravity of 2.7, as determined by a Westphal balance, and which fuse quietly to a clear, colorless glass at 2.5 of Dana's scale. These characteristics demonstrate the mineral as analcite beyond doubt. The dull-red zeolite is quite colorless and isotropic in thin sections; examined in the hand specimen, with a pocket lens, it shows a rhombohedral cleavage, and the small splinters obtainable were found to give the blowpipe reactions of chabazite. Other of the amygdules, from 1 to 3 mm. in diameters are filled by a hard and very brittle dull, dark-brown mineral which always breaks away during the grinding of the section, but which gives blowpipe reactions for hematite.

Hornblende andesite.—From small outcrops on ridge east of Fort Ellis. This is a compact, light-gray rock (No. 62400, U.S.N.M.) with macroscopic brown hornblendes and whitish feldspars. Under the microscope it shows a compact groundmass of feldspar microlites and opacite grains carrying abundant porphyritic hornblendes, plagioclases, and smaller light-green augites. The hornblende is by far the most abundant of the porphyritic constituents, and is readily recognizable by its well-defined crystallographic outlines, though in nearly every case its substance has completely changed to the characteristic opacite granules. The plagioclases are very muddy through impurities and decomposition. The most interesting feature of the rock is the abundant sprinkling of large brick-red pleochroic apatites, as shown in figs. 1–7. These occur in all sizes up to 0.6 mm. The colors vary from colorless through yellow to brick-red, the deeper color being due to innumerable inclosures, which are represented by black dots in the figures. The distribution of the color is not uniform through the whole mass of the crystal, but, as in figure 2, a crystal may be bright yellow at one end and red at the other, or, as in figure 6, red in the center and fading out gradually to colorless at the ends. In the cross section shown

* Neues Jahrb. Vol. II. 1882, p. 41.

in figure 4 the red color is zonal, while the interior is yellowish. Prismatic sections are all plainly pleochroic, being red when the light passes through parallel to the vertical axis and light yellow when at right angles to this axis. A not less interesting feature is the amount of corrosion from the fluid magma which the larger crystals have undergone and which is shown in the figures, especially Nos. 1, 2, 3, and 5. From the fact that the apatite is one of the first minerals to separate out, such results are not unexpected, but, so far as I am aware, have before not been observed to the extent here indicated. This is presumably due to the small size of the crystals, as usually occurring.



Figs. 1–7.

APATITES IN HORNBLENDE ANDESITE.

From specimen No. 38597, U. S. N. M.

The large forms, like figure 7, show a faint cleavage parallel with the prism.

Intrusive rocks: Lamprophyrs.—From the lower part of the Flathead shales, north of the East Gallatin River. The rocks described below outcrop at the base of the sandy shales that lie just above the basal quartzite of the Flathead formation, as exposed in the hills about one mile north of the East Gallatin River. They have been traced eastward about three miles from the most western exposure, where they pass beneath the lake beds, but show again where the Flathead shales cross Dry Creek, three miles farther to the northwest. In all these outcrops they hold the same relation to each other. The upper rock is usually from six inches to a foot in thickness, but sometimes thins out to even less than six inches. It lies in close contact with the shales, is dark gray, nearly black, in color, tough, fine grained, and compact, and shows to the unaided eye only occasional small black crystals evidently belonging to a mineral of the pyroxene group, and numerous small reddish amygdules. This is succeeded by, and seems to pass gradually into, a zone of decomposed material, which carries numerous scales of black mica, and which is traversed in a direction parallel with the sheets by several veins from one to two inches in width of a light pinkish feldspar. The lower or underlying rock, which also seems to pass into this zone of decomposed material, appears to the unaided eye as a holocrystalline mass composed essentially of elongated light pink feldspars and abundant small, often radiating, folia of black mica. The microscopic and chemical properties of this rock are given below. Although the upper and lower rocks belong apparently to two quite distinct types, their constant association, even when in sheets but a few inches thick, is

somewhat confusing. Geologically they appear as one and the same body; from a petrographic standpoint they differ radically. It is useless to speculate on their possible relationships until further outcrops are found, or until, by digging or blasting, the nature of the intermediate zone of decomposed material is made apparent. The total thickness of the eruptive sheet or sheets is about 45 feet.*

Porphyrite (?).—The upper sheet. Macroscopically, this (No. 38599, U.S.N.M.) is a very tough and hard dark gray, nearly black, aphanitic rock bearing abundant small pseudo-amygdules of a dull red or yellowish green color, and with but rarely a black porphyritic mineral sufficiently developed to suggest a member of the pyroxene or amphibole group. In the thin section the rock was found so completely altered that it was only after repeated sections had been cut from samples from various portions of the outcrops that anything like a satisfactory idea of its original nature could be learned. Sections of the freshest samples obtainable show under the microscope a nearly colorless devitrified base, impregnated with innumerable small, sometimes mere dust-like particles of opacite and elongated yellowish mica-like needles in places so abundant as to form a truly feltlike groundmass.

Scattered thickly throughout this groundmass are numerous pseudo-amygdules of calcite, chloritic, and ferruginous substances, and occasional badly shattered, imperfect, and greatly decomposed augites.

The amygdules are due wholly to the decomposition of porphyritic augites and olivines, as can be determined by occasional still quite perfect crystal outlines in the least decomposed portions of the rock, and are in no case true gas cavities filled with secondary minerals. In a few instances the outlines of these cavities were such as to suggest that the decomposed mineral may have been a feldspar, but this can not be determined for a certainty. Sections from the more highly altered portions of the rock exhibit interesting changes. The groundmass here (No. 38599, U.S.N.M.), as above, consists of the colorless base so filled with the mica (?) needles as to be almost felsitic, but the porphyritic augites are replaced wholly by a light greenish-blue, faintly dichroic, somewhat fibrous hornblende. Although optically these secondary forms are undoubted hornblendes giving maximum extinctions on clinopinacoidal section of 15°, their outlines, when sufficiently perfect for measurement, are still, in part at least, those of augite. In a number of cases the prism outlines on cross sections were measured with results varying from 87° to 89°. The cleavage in such cases was somewhat imperfectly developed, but I was able to obtain measurements of the obtuse angle varying from 123° to 125.5°, which is, perhaps, as close as can be expected in sections cut at haphazard. Although the hornblendes are so plainly paramorphic, I have found in no case traces of an augitic nucleus, the change being in all cases complete.

Chemical analysis of so highly altered a rock can be regarded as

* Bull. U. S. Geol. Survey No. 110, pp. 49, 50.

merely suggestive. The following results were obtained by Mr. Eakins on a sample in which the augitic alteration thus described was complete:

	Per cent.		Per cent.
SiO_2	49.47	CaO	9.30
TiO_2	.21	MgO	10.86
Al_2O_3	12.15	K_2O	2.42
Cr_2O_3	Trace.	Na_2O	2.08
Fe_2O_3	1.93	H_2O	4.14
FeO	4.07	P_2O_5	.37
MnO	.10	CO_2	3.31
BaO	.03		

Making due allowances for the various changes attending decomposition, the rock, it will be noted, agrees closely with that from Cottonwood Canon (No. 38596, U.S.N.M.) and Boulder Creek (No. 62409, U.S.N.M.), to be noted later (p. 670).

The association of this rock with that next to be described is peculiar and needs further investigation.

Mica syenite.—Underlying the above. In the hand specimen the rock (No. 38600, U. S. N. M.) appears to the unaided eye as a holocrystalline mass of pink lath-shaped feldspars interspersed with very numerous long, slender, and at times radiating needle-like folia of black mica. As seen under the microscope the structure is quite simple, consisting of a holocrystalline aggregate of badly kaolinized sanidins, lath-shaped plagioclases, scales of mica, scattering granules of iron oxide, apatite needles, and in the interspaces, secondary calcite, plagioclase, and, rarely, quartz.

The most interesting feature of the rock is the almost constant intergrowth of the sanidins with plagioclase, the effect being in the section as if each crystal of plagioclase was set in a frame of orthoclase, as already described and figured in Bulletin 110, U. S. Geological Survey. Unfortunately, in the sample at hand, both feldspars are so badly decomposed that their optical properties are greatly obscured. The plagioclase alteration gives rise to innumerable minute flecks of a silvery white micaceous mineral, and in many cases the twin structures have become entirely obliterated; the potash feldspar has become brown muddy, and opaque, resembling the orthoclase of granitic rocks, and at times acts scarcely at all upon polarized light. A partial analysis of as fresh a sample of the rock as could be obtained, yielded Dr. Chatard results as follows: Silica, 58.88 per cent; potash, 5.18 per cent; soda, 3.46 per cent. The rock is undoubtedly a phase of the syenitic lamprophyre, which was later found in the vicinity of Antelope Creek (p. 671).

Porphyrite.—Intrusive sheets between Dry Creek and Nixons Basin. The rock here is evidently identical with that of the lower sheet of Cottonwood Creek, though the sample collected by Dr. Peale is so badly decomposed that little can be made from it.

Augite porphyrite.—This rock (No. 38596, U.S.N.M.) as displayed in the deep ravine of Cottonwood Creek is dark-gray and coarsely porphyritic, consisting of large and very perfect coal-black augites embedded in a dark-gray, almost holocrystalline feldspathic groundmass. Toward the central portions of the sheet the mass is much the more coarsely crystalline, and through a kaolinizing of the feldspars falls away to a coarse sand. From this sand were picked out in considerable number, still fresh augites in sizes up to eight mm. in length. These are usually elongated in the direction of the vertical axis, though sometimes in short and stout forms of a diameter fully equal to their length, the crystals having the common form ∞P; $\infty P \overset{|}{\infty}$; $\infty P \grave{\infty}$, and P. Twin forms are also common, the more abundant form being that in which $\infty P \overset{|}{\infty}$ is the twinning plane; more rarely occur knee-shaped and clustered forms, evidently twinned after $-P \overset{|}{\infty}$ and $P\grave{2}$.

Approaching both upper and lower contact, the rock gradually becomes firmer and more compact until at last the groundmass is quite aphanitic, though the porphyritic augites still retain their relative size and abundance, appearing on a freshly broken surface of a light, sage-green color. At the line of contact with the shale the rock has the appearance of a brownish, amorphous base, thickly sprinkled with porphyritic augites and feldspars closely cemented to the shale.

Under the microscope the coarser portion of the rock shows an almost holo-crystalline groundmass of lath-shaped feldspars, small augites, scales of brown mica, iron ores, and a large amount of secondary chloritic matter and calcite in which are embedded porphyritic plagioclase feldspars and the large idiomorphic augites already noted. The amount of unindividualized base is very small, and is represented only here and there by small, wedge-shaped areas of greenish, chloritic, decomposition products. In places these are wholly lacking, and the rock assumes the panidiomorphic structure of a diabase.

The porphyritic augites, as seen in the section, are of a very light-green color, not perceptibly pleochroic, and give extinction angles on clinapinacoidal sections as high as 43°. They carry inclosures of iron ore, brown mica, apatite, and glass. The feldspars belonging to the first generation, that is, the porphyritic forms, are all triclinic, with step-like ends and abundant twin striæ. They are somewhat decomposed, giving rise to chloritic and other secondary products.

The only other porphyritic constituent is a greatly decomposed olivine occurring in widely scattered forms, and evidently a nonessential constituent. The decomposition has gone so far that in the majority of cases the resultant forms are no longer recognizable. In a few instances the crystal outlines are still preserved and show steep domal faces and irregular fracture lines, unmistakably those of olivine. The product of the decomposition is in some cases a dull green, chloritic mineral; in others, a dull red, ferruginous amorphous product, accompanied in both cases by abundant calcite. The latter forms are

frequently macroscopically evident on a freshly broken or a polished surface, appearing as dull red areas 1 to 2 mm. in diameter, surrounded by a narrow border of the white calcite. In none of the many sections examined am I able to find even a trace of unaltered olivine.

The feldspars of the groundmass are, in part at least, a plagioclase variety, as shown by the numerous twin striæ. There are, however, abundant clear glassy forms appearing in the section in the form of stout rectangular areas, which in some cases give extinction angles exactly parallel and in others inclined a few degrees from the axis of elongations. These are assumed to be orthoclase, an assumption apparently borne out by the large percentage of potash shown in the analysis. The augites of the groundmass have the same color as the porphyritic forms, but occur in idiomorphic, and also in imperfect, and often sharply wedge-shaped and angular forms filling the interstices of the feldspars. The brownish mica occurs only in small and very irregular shreds associated with secondary chloritic material.

Approaching the line of contact the groundmass becomes more dense, but still retains its largely crystalline character. The porphyritic augites here are of a light sage-green color and show very perfect crystal outlines. They are, however, much more decomposed than those in the coarser and less compact portion, presenting a mass of rounded and angular pale augite fragments, interspersed with calcite, iron oxides and undeterminable decomposition products of a dirty white color. At the immediate line of contact with both over and underlying shales there is a narrow band, from 3 to 6 mm. in width, of a brownish color, consisting of the augites and feldspars of the first generation imbedded in a wholly or partially devitrified base, which remains always light between crossed nicols, and shows a mass of illy defined rounded and elongated globules, over which play imperfect and distorted black crosses as the stage is revolved. Both the feldspars and augites are here replaced by calcite pseudomorphs. The shale itself is strongly injected with calcite for the distance of a few millimeters from the line of actual contact. The line of separation between the shales and eruptive rock is in all cases perfectly sharp, the fused material having flowed over and around the particles of quartz and feldspar in a manner implying a high degree of fluidity. Contact metamorphism of even so large a mass injected in a highly fluid condition, and cooling so slowly as to become almost holocrystalline, is here reduced almost to a minimum, owing to the refractory nature of the materials of which the shales are composed. Thin sections show these to be made up of small fragments of quartz and feldspar with but a small amount of intersticial space now occupied by secondary silica having the same crystallographic orientation as the adjacent quartz granules, and by very minute, needle-like flecks of silvery white mica, evidently developed from the small amount of original amorphous cement. The shale is, therefore, no longer at this point an agglomerate of fragments adhering by means of an amorphous cement,

but is a true crystalline rock, the original fragments forming proportionally large nuclei to a mass of crystalline granules whose regular growth has been interrupted by mutual interference. How much or how little of this change is due to the injected rock it is impossible to say.

Chemical analysis of as fresh a sample of the eruptive as was obtainable from near the central portion of the sheet yielded Mr. Eakins results as follows:

	Per cent.		Per cent.
SiO_2	52.33	MgO	6.73
TiO_2	.14	K_2O	3.76
Al_2O_3	15.09	Na_2O	3.14
Fe_2O_3	4.31	H_2O	2.68
FeO	4.03	P_2O_5	1.02
MnO	0.09		
BaO	0.07		100.45
CaO	7.06	Specific gravity in mass	2.785

Considering all the potash in the above as belonging to the orthoclase and the soda to the plagioclases, these results can be reduced readily to the following proportions:

	Per cent.
Potash feldspar	22.24
Soda-lime feldspar	35.67
Augite, olivine, and mica	31.46
Iron ores, apatite, and decomposition products	10.63

Such calculations must, of course, be accepted only with a considerable degree of allowance. It is probable that a portion of the potash belongs to the plagioclase feldspars, and, without doubt, a small amount to the mica, for which no allowance whatever has been made. This last amount would, however, be trifling. A safer but less definite calculation is as follows:

	Per cent.
Feldspars	58.00
Augite, olivine, and mica	32.00
All other constituents	10.00
	100.00

The above, I believe, represents the proportional qualities of the various constituents as nearly as it is possible to obtain them.

To the west of the outcroppings of the sheet occur rather inconspicuous outcroppings of a darker, more compact rock with macroscopic olivines and augites in macroscopically recognizable forms. (No. 38516, U.S.N.M.) This is described in detail in connection with the basic eruptive overlying the mica syenite between Antelope and South Boulder creeks (p. 671).

During the season of 1886 Dr. Peale brought in from the northwest side of the lower valley of Cottonwood Creek, and labelled as from the "Upper dike," a small specimen of badly weathered, fine grained, light gray rock, thickly studded with small folia of black mica and minute augites. Under a low power the rock appears almost holocrystalline and composed of lath-shaped, short, stout interlocking feldspars, light greenish augites, and scales of brown mica. The feldspars are all muddied through decomposition and optical determinations are very unsatisfactory. A portion of them show twin striæ; others show none and are presumably in part sanidin.

The augites are all small (one-third mm. in greatest diameter), and as a rule in imperfect and fractured forms. Cross sections, however, frequently show quite perfect outlines. They are very light greenish in color in the section. The mica is reddish-brown, strongly dichroic, and occurs in irregular shreds, in very perfect hexagonal tablets, as a narrow border about the iron ores, and in a few instances was observed a like border about elongated augites.

A high power shows the interstices of the feldspars occupied by a colorless isotropic substance or a very light green chloritic material evidently derived therefrom. When an uncovered slide is treated with hydrochloric acid there are shortly produced abundant cubes of sodium chloride. So abundant were these cubes that careful search was made for nepheline or sodalite, but with unsatisfactory results. The cavities left in the slide after treatment with hydrochloric acid presented in no cases the outlines of any crystallized mineral, but are in all cases irregular areas scattered promiscuously throughout the mass of feldspars. For the time being the true nature of the isotropic mineral which gave rise to these was a mystery, but in the light of subsequent observations there seems little doubt but that they are of sodalite and the rock a phase of the mica and augite bearing syenitic lamprophyres, described later (p. 671). A partial analysis of the rock yielded Mr. Eakins results as follows:

	Per cent.
SiO_2	54.29
Al_2O_3	18.47
Fe_2O_3	5.67
CaO	3.69
MgO	3.98
K_2O	5.92
Na_2O	4.13
	96.15

Augite porphyrite.—Intrusive sheet some sixty feet in thickness just above Horse Shoe Bend of the Missouri River. In strike and dip it follows the Cretaceous sandstone in which it lies, cutting across the beds only very slightly, if at all. It is well exposed in the bluffs on the west side of and facing the river. Both upper and lower contact are here readily found.

The rock (No. 62410, U.S.N.M.) is evidently identical with the main eruptive at Cottonwood Creek, Gallatin County, some 6 miles to the southeast, and which was called an augite porphyrite in Bulletin No. 110, U. S. Geological Survey. (See above.) Like that rock, it is dark greenish and at times nearly black in the least decomposed samples and thickly studded with stout idiomorphic augites of all sizes up to 10 mm. in length. Near the line of contact the rock is almost aphanitic, but shows under the microscope abundant porphyritic augites and plagioclases in good idiomorphic forms in a felsitic base. Receding from the line of contact the rock grows gradually coarser, and thin sections show the rate of cooling to have been sufficiently slow for an abundant development of a second generation of plagioclases. Whether any glassy base remained can not now be determined, as everything is obscured by decomposition products. As with the Cottonwood Creek rock, there are abundant iron oxides in large grains, numerous small scales of dirty brown mica and occasional apatites. The augites occur in simple, and twinned and in clustered *glomero-porphyritic* forms.

Quite a number of the porphyritic feldspars show beautiful zonal structure and no twinning. Such are assumed to be sanidins, an assumption borne out in the Cottonwood Creek rock by the high percentage of potash shown in the analysis. The microstructure varies from hypocrystalline porphyritic to holocrystalline porphyritic with a panidiomorphic groundmass.

The only difference which can be considered at all essential between this rock and that of Cottonwood Creek lies in the development in the former of abundant olivines, which, however, are now recognizable only by the outlines of the dirty yellow brown chloritic decomposition products. A few of these were present in the Cottonwood Creek samples, but they were so scattering as to be deemed nonessential.

Hypersthene andesite.—Northwest of Red Bluff. This is a very fine-grained and compact nearly black rock (No. 66929 U.S.N.M.) breaking with an irregular choncoidal fracture and in which none of the constituents are developed in such size as to be determined by the unaided eye.

In the thin section the rock shows an amorphous, glassy base so charged with opacite dust as to be itself almost black and opaque, and bearing very numerous irregularly lath-shaped plagioclases and abundant crystals of a colorless pyroxene. More rarely occur olivines which are in all cases altered to a greenish yellow chloritic product.

The plagioclases are many of them imperfectly secreted from the base and their borders are thickly charged with the black opacite. The pyroxenic mineral is in nearly colorless, very imperfectly outlined elongated forms, often broken transversely and rarely of such size as to show in basal sections prismatic cleavage lines cutting at nearly right angles.

The dichroism is very faint and in the larger forms only could it be

made out with any degree of certainty: ċ, very light greenish; ȁ, very faintly reddish, and b̄, faint yellowish, scarcely at all reddish. The mineral shows extinction in all cases parallel and at right angle with the *c* axis; it is biaxial, negative, and sections cut at right angles to the *a* axis show the immergence of a bisextrix with the plane of the optic axes in that of the *a* and *c* axes. Dispersion $\rho > v$. These characteristics alone are sufficient to demonstrate the true character of the mineral.

Mr. J. S. Diller, of the U. S. Geological Survey, has kindly loaned me sections of the hypersthene basalt described by him from Mount Thielson, Oregon,* from an examination of which I am able to make the following comparisons: the two rocks have essentially the same structure, but differ in that the sample from Red Bluff shows a relatively smaller number of porphyritic plagioclases, a far larger proportion of hypersthene, and also a larger proportion of plagioclases in the groundmass, necessitating therefore a smaller proportional amount of glassy base. The feldspars of the Oregon rock are much better developed than in that of Red Bluff and the "opacite" particles much larger and more distinctly granular. Bulk analysis of the Red Bluff rock by Mr. Eakins yielded results as below. In column II is given that of the Mount Thielson rock, permission for the use of which has been kindly granted by Mr. Diller.

	I.	II.
	Per cent.	*Per cent.*
SiO_2	59.48	55.68
TiO_2	0.93	....
Al_2O_3	16.37	18.93
Fe_2O_3	3.21	....
CaO	4.88	7.99
MgO	3.29	4.86
FeO	3.17	8.73
BaO	0.13	....
Na_2O	3.30	2.12
K_2O	2.81	.48
P_2O_5	0.41	....
Ign	2.01	.60
	99.99	99.39

From this it would appear that the rock is much more nearly related to the andesites than the basalts, although on purely structural grounds it seems more like the latter.

Peridotite, var. Wehrlite.—Hills three miles northwest of Red Bluff. This rock (Nos. 70675 and 73162, U.S.N.M.) occurs intrusive in the gneiss and forms on the present surface only several small, nearly circular, inconspicuous outcrops, standing but a few feet above the surrounding gneiss and broken into rough, angular blocks weathering brownish. Two textural varieties are readily apparent. One, a somewhat coarse, distinctly crystalline rock, showing on fresh surfaces

* Am. Jour. Sci., XXVIII, 1884, p. 252.

mottled, deep bright green cleavage plates (sometimes 5 to 10 mm. across) of a mineral of the pyroxene group, and abundant small folia of brown mica. To the unaided eye these two minerals form the chief constituents of the rock. This variety weathers with peculiarily knobbed and deeply pitted surfaces.

The second variety differs only in being of finer grained and more uniform texture, its mineralogical nature being barely evident even with a pocket lens.

Both varieties are, however, essentially the same. Under the microscope the rock is found to be beautifully fresh and unaltered—a holocrystalline granular aggregate of pale green diallage, deep reddish-brown mica, colorless olivines, rarely small irregular areas of a basic plagioclase, and scattering patches and streaks of black iron oxides, which are evidently wholly secondary. None of the constituents present anything like perfect crystal outlines.

The structure is peculiarly jumbled and almost cataclastic. It resembles more the hasty and interrupted crystallizations characteristic of certain meteorites, like that of Estherville, Iowa, than that of terrestrial rocks. Diallages and olivines are crowded and jumbled together, the interstices of the larger forms being occupied by the same minerals in a granular condition.

The diallage has reached the most perfect stage of developement and often occurs in broad plates inclosing olivines and shreds of brown mica, and with a very pronounced pinacoidal parting. Feldspars, when they occur, are in short broad plates sometimes polysynthetically twined or again showing broad faces without trace of cleavage or twining lines and filled with small colorless and yellow interpositions of mica. (?) The prevailing mica is deep brownish-red and strongly pleochroic. The following shows the composition of the rock according to analysis by Mr. L. G. Eakins, of the U. S. Geological Survey:

	Per cent.		Per cent.
SiO_2	48.95	MgO	23.49
TiO_2	.81	BaO	Trace.
Al_2O_3	5.69	K_2O	.79
Cr_2O_3	.05	Na_2O	1.58
Fe_2O_3	1.20	H_2O	.18
FeO	12.11	P_2O_5	.12
MnO	.08		
NiO	.16		100.54
CaO	5.33	Specific gravity	3.37

Diorites.—Burnt Creek region. These rocks are apparently all diorites and presumably portions of the same geologic body, though differing somewhat in composition and in details of structure. Some are fine and evenly granular dark-gray rocks, showing under the microscope a holocrystalline, panidiomorphic granular structure, a portion of the plagioclases only showing idiomorphic developement. A green hornblende in very irregular plates and shreds is, next to the plagioclase,

the predominating constituent. Shreds of brown mica, abundant granules of iron ore, occasionally a little interstitial quartz, and a few inconspicious apatites with rarely an irregular sphene complete the list of determinable constituents. Others differ mainly in being of coarser texture and showing a tendency toward a porphyritic structure through the development of occasional large plagioclases.

Two sections show peculiar modifications. The most abundant constituent is a pale green augite which has gone over to a considerable extent to chlorite and a uralitic hornblende. Both augites and plagioclases show a tendency to group themselves into granular aggregates, while the latter are in many instances so charged with globular, club-shaped or vermicular colorless inclosures as to almost obscure their true mineral nature.

The feldspar not infrequently appears as a ragged, irregular nucleal area, with or without twin striæ, and surrounded by a zone of varying width of the inclusions so as to appear, by a low power, like a very fine granular aggregate of colorless minerals. A single section shows all gradations from feldspars with no inclusions to areas no longer recognizable as such, but merely aggregates of the irregular inclusions described. The structure is at times pronouncedly cataclastic and the appearances such as to indicate that the above-mentioned peculiarities are due to dynamic causes.

Rhyolite and andesite.—Hills between North and South Meadow Creek, near Washington Bar. The eruptives here occur mainly on the eastern side of the creek and form the steep hills lying between the north and south branches. The predominant rock is a liparite overlying the gneiss and forming the main mass of the hill. This varies from purplish to gray or nearly white in color, sometimes pinkish. The ordinary type is faintly porphyritic, though sometimes quite aphanitic, and with so even and pronounced a flow structure as to closely simulate a compact, thin bedded, argillaceous limestone. On the eastern and upper slope of the hills, and particularly at the western end of the range, always near the contact between the liparite and gneiss there occur limited outcrops of a dense almost coal black andesite. (No. 72850, U.S.N.M). The contacts between the three rocks are never accessible, but the surface of the ground is simply covered with innumerable small joint blocks, rarely a foot in diameter, and which have been further reduced by the continual flaking off of small convex and concave chips by diurnal temperature variations. The rock on a weathered surface for perhaps the depth of a millimeter is of a brownish color. Beyond this it is always fresh, of a beautiful dense black color and satiny luster, and with only rarely small white porphyritic constituents sufficiently developed to be visible to the unaided eye.

A slight mottling sometimes seen on the surface is due to a spherulitic development. The field characteristic of the rock was such that

it was supposed to be a basalt. The thin section, however, shows only a very dense aggregate of small feldspars and other colorless microlites, often with strongly marked fluidal structure and innumerable small opaque specks, assumed to be iron oxides. None of the magnesian silicates are sufficiently developed to be recognizable, even with the highest powers. The white porphyritic constituents mentioned above as occurring rarely, prove to be secondary segregations of quartz.

The microstructure of the rock is andesitic rather than basaltic; nevertheless, as I have never before seen any but the glassy andesites so dark in color and so compact, a test was resorted to which showed 64.42 per cent. of silica; specific gravity, 2.555.

Hornblende picrite.—North Meadow Creek. This rock (No. 73174, U.S.N.M.) in the hand specimen is of an iron-gray color and composed of very irregularly outlined crystal plates and fibers, from one to two centimeters broad, which to the unaided eye merge into one another without sharp lines of demarkation. The larger plates inclose rounded blebs of a deep green mineral, whereby is produced an indistinct and irregular luster-mottling. The rock weathers brownish on the immediate surface, but is apparently fresh and unaltered and so intensely tough and hard that a two-pound hammer quite failed to detach chips of any size, and recourse was had to the sledge.

The outcrops are few and rather inconspicuous, projecting in thin wedges but a few feet above the scanty soil, and ringing like metal when struck with the hammer. Although no contacts were visible, the strike is directly across that of the gneiss in the vicinity, and in the field no doubt was felt concerning its eruptive nature.

In the thin section, under the microscope, the rock shows a holocrystalline aggregate of light greenish to colorless hornblendes, abundant, beautifully fresh, and colorless olivines, irregular grains of pleonast, the usual sprinkling of iron ores, and occasional very imperfectly outlined areas of a faint brown, dichroic mineral, showing in an indistinct basal section a very irregular and interrupted nearly rectangular prismatic cleavage. Satisfactory determination of this mineral was impossible. It is evidently hypersthene. The hornblendes occur in broad ophitic plates of a green color, inclosing the rounded clear and fresh olivines, and also in colorless frayed-out asbestus-like forms. Were it not that the rock is so fresh and unaltered I would be disposed to regard such as secondary forms, perhaps after a rhombic pyroxene, but it seems scarcely probable that such an alteration could have taken place, leaving the olivines, which they inclose, so perfectly fresh and unchanged.

The rock belongs to the group of hornblende picrites, as defined by Bonney, and though a trifle more acid, seems to correspond fairly well with those described by him from Anglesea and figured by Teall on pls. V and VI, figs. 2 and 1, respectively, of his British Petrography. The rock is sufficiently rich in olivine to gelatinize readily in hydro-

chloric acid. Below is given the results of a bulk analysis of the rock as made by Mr. Eakins:

	Per cent.		Per cent.
SiO_2	46.13	BaO	Trace.
TiO_2	.73	K_2O	Trace.
Al_2O_3	4.69	Na_2O	.08
Cr_2O_3	.04	H_2O	1.38
Fe_2O_3	.73	P_2O_5	.07
FeO	16.87	S	.24
MnO	Trace.		
NiO	.09		100.63
CaO	4.41	Specific gravity	3.35
MgO	25.17		

Saxonite; Harzburgite.—From dike between North and South Meadow creeks. This rock (No. 62402, U.S.N.M.) was first noticed on the western side of the divide between North and South Meadow creeks, where it cropped out by the roadside in the form of a sheet not over 50 feet in width, of a plainly laminated deep green serpentinous rock lying in the gneiss, and apparently corresponding with it in dip and strike. The outcrop was traced in a southerly direction toward South Meadow Creek, finally disappearing at the lake branch of the creek. Everywhere the rock had the appearance of a highly tilted metamorphic schist, except at the extreme southern terminus, where it widened out into a bulbous enlargement which was serpentinous on the margins, but showed a nucleus of a dense dark gray, very tough, and hard rock made up of a macroscopically irresolvable groundmass thickly studded with imperfectly outlined phenocrysts of a pyroxenic mineral with a bronze luster. The conditions of the rock were such as to at once suggest that this nucleus represented the unaltered portion of an original eruptive mass from which the schistose serpentine had been derived by chemical and dynamic agencies. This suggestion was substantiated by chemical and microscopic examination.

The rock from the southern end of the dike, in its least altered conditions, shows under the microscope a dense groundmass of finely granular colorless rhombic pyroxenes and pale brown almost colorless hornblendes, interspersed with a few olivines, the usual sprinkling of iron oxides, and small rounded forms of dull green pleonast. Throughout this ground mass are scattered the bronzite phenocrysts above noted, more rarely irregular olivines, occasionally very irregular plates of faintly brownish or greenish hornblendes and more rarely shreds of a deep red-brown mica which show extinction angles of about 3°, when measured against cleavage lines in cross sections. In but one or two instances were observed small granules of a basic plagioclase feldspar. Bronzite and olivines make up the main mass of the rock.

The structure of the rock is quite variable and complex, and difficult to describe intelligibly. With the exception of certain of the hornblendes of the groundmass, none of the constituents show good crystal-

lographic forms, but occur in comparatively broad, very irregularly outlined plates surrounding and inclosing blebs of olivine and portions of the groundmass. The bronzite phenocrysts show a very platy, at times almost fibrous, structure, and have as a rule bronze clouded interior areas surrounded by colorless margins.

This type of the rock passes quite abruptly into serpentine, the olivines succumbing first and the bronzite next, the hornblendes remaining intact to the last but finally going over to fibrous tremolite forms. Accordingly as olivine or bronzite predominated in particular instances, the sections show a serpentine of the well-known mesh, or bar and grating structure.

As the process of alteration is traced into the more schistose portions of the rock it is observed that the unaltered hornblendes assume an approximately parallel arrangement among themselves, their longer axes lying in one general direction, while a pale yellowish mica is in some cases developed, particularly in slides from specimens taken from near the contact with the gneiss. The appearance is such as to suggest that the apparent fissile structure is due to a lateral compressive or sheering force as in ordinary roofing slates, and that the force may have been produced by movements in the inclosing gneiss, or, as seems possible, to merely the expansion of the mass of rock itself during the process of hydration and while held firmly by the walls of gneiss. The sufficiency of this expansive force to produce a platy and slickensided structure in pyroxenic masses undergoing hydration the present writer has elsewhere alluded to.* The following analysis, by myself, shows the composition ot the fresh, unaltered saxonite from the southern end of the dike, all the iron being determined as Fe_2O_3 and the rarer elements not looked for:

	Per cent.
SiO_2	46.35
Al_2O_3	16.41
Fe_2O_3	9.91
MgO	18.72
CaO	6.14
Ign	3.01
	100.54
Specific gravity	3.21

Pyroxenite.—Outcrop in gneiss. On divide between Meadow and Granite creeks. Macroscopically this (No. 73175, U.S.N.M.) is a massive holocrystalline granular rock in which stout, deep dark-green, nearly black, crystals of a hornblendic mineral in sizes up to five and eight mm. in length are interspersed with larger indefinitely outlined areas, sometimes 40 or 50 mm. in diameter, of a brownish eminently cleavable mineral, suggestive of a pyroxene. These two minerals, so far as can

* On the Serpentine of Montville, New Jersey. Proc. U. S. Nat. Mus., XI, 1888, p. 105.

be determined macroscopically, made up the entire mass of the rock. Its appearance may perhaps be better understood by comparing it to a conglomerate in which the large pyroxenic portions represent pebbles and the hornblendes the interstitial cement. The rock is very massive, and I am inclined to believe an eruptive, though definite proof is lacking. Eruptive or otherwise, it seems to cover a very limited area. The country rock is gneiss with a pronounced banded or foliated structure. Passing along through the woods one comes suddenly upon an exposure of this rock utterly different in mineral nature and structure, and occupying an area so far as exposed scarcely a hundred feet in diameter. Like so many other undoubted eruptives in the region, it occurred in the form of what we after a time dropped into the habit of facetiously calling *pustules*. Inasmuch as I have never seen any such sudden transitions in gneissic rocks, but have observed basic undoubted eruptives occurring in just this manner, I am naturally inclined to regard this also as an eruptive, though contacts are wholly obscured. It is apparently the deeper lying portion of an old and very small volcanic neck.

Thin sections under the microscope show the rock to be made up wholly of large, irregularly outlined plates of hypersthene, pleochroic in faint reddish and brownish colors, and a light-green hornblende, as above indicated. These, with a scattering of opaque granules of iron ore, comprise the entire list of recognizable constituents. The rock is beautifully fresh and unaltered. The crystallization of the two chief constituents must have been nearly contemporaneous. The hypersthenes never show good idiomorphic forms, but the borders are irregularly indented by the smaller hornblendes, which are also found in quite perfectly outlined forms wholly inclosed by the hypersthenes. As a rule, as noted above, these hornblendes occupy the position of a binding constituent, but at times both hornblendes and hypersthenes occur intimately associated in small, imperfect granular forms. Of the two minerals the hornblendes are the better developed. These show on cleavage plates parallel to $\infty P \grave{\infty}$ extinction angles as high as 14°. An analysis yielded results as below, all the iron being determined as Fe_2O_3:

	Per cent.
SiO_2	46.14
Al_2O_3	17.07
Fe_2O_3	8.45
CaO	11.70
MgO	15.01
K_2O	.10
Na_2O	1.11
	99.58

The rock belongs evidently to the group of pyroxenites as described by Williams,* but can not be classed under any of the varietal names

* Am. Geologist, July, 1890, pp. 40–49.

as given by him. *Hornblendite* includes the closely related hornblende augites forms and *hypersthenite* the pure hypersthene rock. The compound name hornblende-hypersthenite, while sufficiently descriptive, is too cumbersome, but it seems scarcely advisable to coin a new name until rocks of this type shall be shown to have a wider geographic distribution.

Below is given the results of a bulk analysis as made by Mr. Eakins (I). In II is given the composition of a bronzite diallage rock (Websterite) from near Webster, N. C., as described by G. H. Williams.*

	I.	II.		I.	II.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
SiO_2	51.83	55.14	MgO	24.10	26.66
TiO_2	.29	....	BaO	....	....
Al_2O_3	7.98	.66	K_2O	.06	....
Cr_2O_3	.31	.25	Na_2O	.35	.30
Fe_2O_3	1.48	3.48	Ign	.29	.38
FeO	8.28	4.73	P_2O_5	.09	.23
MnO	Trace.	.03			
NiO	.11	....		100.43	100.25
CaO	5.26	8.39			

Between South Meadow and Moore Creek was found a second inconspicuous outcrop of what is evidently a varietal form of the same rock (No. 62401, U.S.N.M.). As in the last case, the outcrop is in the gneiss, nearly circular in outline, and of very limited area, not over 100 feet in greatest diameter. The actual contact between the eruptive and the gneiss was obscured by a zone, some three or four feet wide, of decomposed material, and here again there may be some reason to doubt the eruptive nature of the rock. To consider it as an eruptive is certainly the easiest way out of the difficulty, since it is more difficult to explain how mineral aggregates of this nature could segregate out of gneissic rocks of entirely different mineralogical composition than it is to account for the coarse and uniform crystallization in eruptive masses of so small size.

The rock in the hand specimen is dense, dark greenish in color with a serpentinous look and flecked with abundant cleavage plates of dark-green hornblende. On the immediate surface the rock weathers to a rusty red and shows not infrequently small rounded garnet-like protuberances, which closer examination shows to be large hypersthenes left projecting, owing to their superior durability.

In the thin section the rock shows plates of faintly greenish, to almost colorless hornblendes, interspersed with short, stout hypersthenes and occasionally olivines, and very abundant, comparatively large, irregular deep-green pleonasts with which is nearly always associated a magnetic iron ore which gives a chromium reaction when tested in the borax bead.

The rock is very fresh, although a slight serpentinization has begun

*Am. Geologist, July, 1890, p. 44.

with the olivines. The spinels are so abundant as to be the most striking feature of the slide and are readily recognizable by the unaided eye, in the form of irregular opaque granules a millimeter or so in greatest diameter.

From the powdered rock the spinel was separated out by digestion with hydrofluoric acid. The material thus obtained yielded Mr. Eakins results as below:

	Per cent.	
SiO_2	0.55	
Al_2O_3	62.09	ratio 1
Cr_2O_3	2.62	
Fe_2O_3	2.10	
FeO	17.56	ratio 1
MnO	Trace.	
CaO	.16	
MgO	15.61	
	100.69	
Specific gravity at 32.3° c	3.89	

This reduces readily to the spinel formula $(Mg,Fe)O.Al_2O_3$, which is that of the variety pleonast, to which the mineral has already been referred.

A bulk analysis of the rock yielded me results as below, no attempts being made at determining the rarer constituents:

	Per cent.
SiO_2	44.01
Al_2O_3	11.76
Fe_2O_3*	15.01
MgO	25.55
CaO	4.06
	100.39

Diabase.—Granite Creek, Madison County. These are coarsely crystalline rocks (No. 62403, U.S.N.M.), in most cases readily recognizable in the field as diabases, though in some instances the uralitization of the augitic constituent had gone so far that in the hand specimen the rock might easily be mistaken for a diorite. In the thin section they present nothing of special interest. The ophitic structure characteristic of diabases is not prominently developed. There are broad areas of badly kaolinized plagioclases interspersed with augites, iron ore, and occasional quartz granules and shreds of brown mica, together with more or less uralitic hornblende and chlorite.

Basalt.—The high flat-topped plateau northeast and east of Virginia City is composed exclusively of basalt with interbedded tuffs, the whole being underlaid by andesites, which are exposed only in the dry gulches down well toward the level of the town (Nos. 62405 and 62406, U.S.N.M.). The basalts vary in color from dull reddish to

* All iron determined at Fe_2O_3.

nearly black, and in structure from coarsely vesicular to compact, and, as a rule, showing olivines developed in such sizes as to be recognizable to the unaided eye.

As a rule the samples collected present no points of exceptional interest, though from an outcrop on the divide between the two south branches of Moore Creek a quartzose variety was found which needs mention. Macroscopically the rock is dense, compact, of a dark-gray color, and studded with numerous rounded or oval spots, 2 to 3 mm. in diameter, showing a whitish center surrounded by two narrow zones, the inner greenish in color, and the outer, an irregular and imperfect one, whitish. In the thin sections these spots show a rounded nucleus of quartz surrounded by a zone of pale-green augite, and these in turn surrounded by a zone of nonstriated feldspars (?). The nature of this last constituent could not be made out beyond doubt in the sections at hand. The mineral is biaxial and gives inclined extinctions, the general behavior being that of a potash feldspar. With the exception of this imperfect outer zone the occurrences are apparently in every way similar to those described by Diller* and Iddings,† and are to be accounted for in a similar manner.

Hornblende andesite.—Old Tollhouse on road leading from Postlewaite Creek toward Virginia City (No. 72867, U.S.N.M.). This is a gray andesite of ordinary type, showing to the unaided eye coal-black hornblendes, hexagonal folia of black mica from one to two mm. in diameter, and abundant small plagioclase phenocrysts. The microscope brings to light no points of unusual interest. The rock is finely exposed in the hillside at the tollhouse, and is found to underly the basalt forming the plateau to the west. The same rock occurs again at Virginia City, where it has been used in the construction of several buildings. On the east side of Alder Gulch, also underlying the basalt, a similar rock occurs, but in which the hornblende seems to have been wholly replaced by the black mica.

Liparites.—Cherry Creek on west side of Madison Valley. The only eruptives here (No.72945, U.S.N.M.) are liparites and diabases, the first occurring only in remnants of thin sheets on the slopes north of the creek, and in isolated patches for several miles to the southward. The prevailing type is a light reddish or gray and but slightly porphyritic rhyolite, sometimes coarsely spherulitic. The material is of such slight density as to have been transported by spasmodic streams clear to the opposite side of the valley in masses of even 10 feet in diameter. Wind-blown sand has in many cases hollowed these out into a mere shell. Older eruptives in the form of dikes of diabase occur well down in the edge of the valley, outcrops running parallel with the prevailing schists. These in the hand specimens are holocrystalline granular rocks, dark gray in color, and in which an

* Am. Jour. Sci., XXXIII, Jan., 1887, p. 45.
† Am. Jour. Sci., XXXVI, Sept., 1888, p. 208.

abundant sprinkling of a dark-greenish black hornblendic mineral in a gray feldspathic base is readily recognized.

In the thin sections the most abundant constituent is hornblende, in broad plates of green color and fibrous aspect such as to at once suggest that they are wholly secondary, that is, uralitic; accompanying these are small, irregular flecks of brown mica, which is also secondary. The groundmass of the rock is composed of badly kaolinized feldspars, in part at least plagioclastic, and granular quartz. Frequent patches of a dirty brownish amorphous matter, acting between crossed nicols like a gum, are evidently residual products from the decomposition of titaniferous iron. Mineralogically the rocks may be classed as quartz diorites, but I am inclined to regard them as altered diabases.

Porphyrite.—On the eastern side of the valley, in the upper valley of Bear Creek, the eruptives occur in the form of three sheets of porphyrite, a liparite, and two inconspicuous outcrops of a dense greenish basaltic rock closely related to that described as occurring near Fort Ellis. Between Bear and Indian Creek, to the southward, are extrusions of basalt. The most conspicuous eruptive on this side of the valley is that forming the mass of Lone Mountain, and which is found in the form of sheets and dikes in the Cretaceous and older beds of the surrounding hills. As exposed in the canon of Cedar Creek (Nos. 72866 and 72880, U.S.N.M.), the mass is evidently laccolitic in Cretaceous sandstones. The entire thickness of the mass as exposed can not be less than 3,000 feet. In its most conspicuous development the rock is a compact light-gray hornblende porphyrite, with both hornblende and feldspars sufficiently developed to be recognizable by the unaided eye. Black mica is commonly present, and near the lower contact this mineral prevails, to the entire exclusion of the hornblende. (No. 72880, U.S.N.M.) This variety of the rock is further characterized by abundant rounded blebs of quartz.

In the thin section the prevailing type shows a groundmass varying from densely microlitic or felsitic in samples from near upper contact to finely microgranular in specimens more remote. Phenocrysts of striated feldspars and green hornblendes are abundant, and occasionally rounded blebs of quartz occur. The feldspars are in most sections opaque through decomposition, and an abundance of secondary calcite indicates that they belong to a lime-rich variety. The mass, as shown by specimens collected at various points, is very uniform throughout in structure and mineral composition. Near the lower contact, as found in the canon of Cherry Creek, it becomes a dense, almost porcelain-like rock, breaking with a beautiful conchoidal fracture (No. 66928, U.S.N.M.). This variety shows under the microscope a dense felsitic groundmass, with many small, rounded, and wedge-shape bits of quartz and feldspars. Through weathering, the upper portion of the peak has become hollowed out so as to resemble a volcanic crater broken down on the side facing the valley. The rock is

also exposed in the upper portion of Jackass Creek, together with dikes of diabase.

Pyroxenite; Websterite.—Well up on the hills north of the first basin of Jackass Creek was found another inconspicuous outcrop of a doubtfully eruptive rock somewhat similar in its mode of occurrence to the pyroxenites already described. In the hand specimen the rock (No. 62442, U.S.N.M.) shows to the unaided eye a granular aggregate of dark bronze, gray, and green minerals suggestive at once of a pyroxenite. Thin sections under the microscope show a fine granular aggregate of light-green diallage and colorless enstatite with included folia of brown mica, and occasional interstitial areas of lime soda feldspars and more rarely a colorless biaxial mineral, showing in polarized light the wavy banding characteristic of intergrowths of orthoclase and albite. An attempt at isolating this mineral for microchemical tests proved unsuccessful owing to its small quantity. The colorless mineral thus obtained gave always, when evaporated with hydrofluorsilicic acid, abundant beautifully perfect hexagonal forms of sodium silico-fluoride and stellate groups of calcium silico-fluoride, but no potash salts so far as could be observed. The percentage of potash shown in the bulk analysis is, however, suggestive of some other potash-bearing mineral than the mica, though it is of course possible it may come in part from the pyroxenes. The diallage is but faintly green and at times almost colorless in the section, and with difficulty distinguished at all times from the enstatite. Besides the usual prismatic cleavage it shows distinct partings parallel with both $\infty P \bar{\infty}$ and $\infty P \breve{\infty}$. In longitudinal sections it is at times quite fibrous, but carries no inclusions of note except the brown mica. The enstatite is almost perfectly colorless and never noticeably dichroic. Enstatite and diallage make up the main mass of the rock, the former being more conspicuous in the hand specimen.

The rock must evidently be classed with the pyroxenites, though showing transitional tendencies toward gabbro.

Bulk analysis yielded me results as below. The ignition with sodium carbonate indicated the presence of manganese, but which was not determined quantitatively. Chromium and other rarer elements not looked for. All iron calculated as FeO.

	Per cent.
SiO_2	54.12
Al_2O_3	7.91
FeO	12.87
CaO	6.21
MgO	16.64
K_2O	1.19
Na_2O	.44
	99.38
Specific gravity in bulk	3.30

Diorite porphyrite.—About six miles northwest from Three Forks, Jefferson County. The eruptives occur here in the form of three approximately parallel ridges. The outcrops are not continuous, but form a series of rounded knolls covered with scanty soils through which project the angular or rounded fragments into which the rock weathers.

The most easterly of the three ridges shows outcrops in large rounded masses of a coarse gray and pinkish granitic-appearing diorite in which black hornblende and pinkish or gray feldspars are easily recognized by the unaided eye. This, separated by wide ravines and benches, is succeeded by a compact dark gray fine-grained micaceous rock in which only small scales of black mica in a very finely granular base are recognizable, and this in its turn by a very typical diorite porphyrite, a dark gray very compact rock thickly studded with black hornblendes of all sizes up to 15 or 20 mm. in length, and often in stellate clusters of radiating individuals some 25 mm. in diameter. The field relationships of the last two varieties were somewhat obscure, but although never observed grading into one another, little doubt was felt at the time but that they were portions of the same mass.

In thin section the first mentioned (No. 73170, U.S.N.M.), the granite-like rock, is found to consist of large plates of muddy and impure orthoclase and plagioclase feldspars with interstitial quartz, deep green hornblendes, and occasional light-green augites, scattering apatites, sphenes, an occasional zircon (?), and the usual iron ores. The second variety, the compact finely granular rock with microscopic mica shows in the section a finely holocrystalline groundmass of stout idiomorphic plagioclases and orthoclase in broad plates with abundant sprinklings of green hornblende, paler green augites, brown mica, iron ores, apatites and sphenes. A part of the hornblendes are original and a part secondary after the augites. The rock is not distinctly porphyritic, and the structure as a whole is panidiomorphic. Occasional large plates of a nonstriated feldspar inclosing small augites and plagioclases give rise to ophitic forms. The third, the porphyritic variety, shows a similar mineral composition, but somewhat variable structure. Certain slides show a dense microgranular feldspathic base carrying occasional rounded blebs of quartz and phenocrysts of plagioclase and deep green hornblende and smaller augites in good idiomorphic forms; others show a structure almost granitic and with interstitial quartz. Hornblende occurs both as phenocrysts and as a constituent of the groundmass, but in the latter case is always an alteration product of the augite. Mica in this variety of the rock is much less abundant than in the last, and is at times almost wholly lacking. All intermediate grades of structure exists from the close-grained porphyritic to the granitic, and the mass as a whole, if as supposed all portions belong to the same magma, offers an interesting field for those who are disposed to make structural differences a basis for rock classification.

Quartzose hornblende porphyrite.—Willow Creek at Lower Canon. The eruptive here occurs as an intrusive sheet or boss through the Potsdam quartzites. On the east side of the creek the mass is practically a boss, throwing the quartzites on the north far out of position. Near the canon the mass begins to narrow and passes westward as a broad sheet or dike dipping with the quartzites which appear both above and below.

In the canon the eruptive is finely exposed in vertical cliffs a hundred or more feet in height and is broken by nearly vertical joints into rudely columnar masses from six to ten feet in diameter. By joints running parallel with the strike the rock is in places also broken into a series of sheets varying from an inch to a foot or more in thickness. East of Willow Creek the main sheet divides, forming two sheets, with the Potsdam quartzites and shales lying between them, and through which has been extruded a brownish coarsely porphyritic andesite.

The normal rock (No. 62407, U.S.N.M.) is a dense light gray, sometimes almost white or faintly yellowish, felsitic to microgranular mass with inconspicuous phenocrysts and imperfect needle-like hornblendes. No quartzes are microscopically apparent. Occasional bands are apparently holocrystalline, though this variety was so badly decomposed as to crumble and samples fresh enough for study were not obtained.

In the section the rocks show a very dense microcrystalline groundmass of quartz and feldspar particles, bearing abundant micro-phenocrysts in the form of dihexahedral quartzes and larger feldspars, a large portion of which are orthoclase, though a few striated forms are occasionally seen. The hornblendes, although recognizable macroscopically as fine needles, are scarcely visible at all in the section owing to a decomposition which has given rise to calcite and chloritic products. The only striking feature of the rock is the abundance of the small quartz phenocrysts and their peculiar skeleton-like forms, due to numerous empty cavities and inclosures. Partial analysis on a fresh compact sample yielded:

	Per cent.
SiO_2	67.43
K_2O	3.40
Na_2O (by difference)	5.87

The hornblende andesite mentioned above (No. 62408, U.S.N.M.) is macroscopically a somewhat dense, brownish or gray rock thickly studded with white feldspar phenocrysts in all sizes up to ten mm. in greatest diameter. In the thin section it shows a dense feldspar microlitic groundmass with strongly marked fluidal structure, and which bears only the porphyritic feldspars above noted, and numerous badly decomposed and corroded areas which form their outlines are assumed to have

been hornblendes. Subjected to chemical tests the rock yields 2.5 per cent. of potash (K_2O).

Lamprophyres.—Between South Boulder and Antelope creeks. The intrusives here are a gray to pinkish micaceous syenite and a dark gray, basic porphyritic rock immediately overlying it. Both are intrusive in Cretaceous sandstones. The basic rock (No. 62409, U.S.N.M.) occurs in a sheet apparently fifteen to twenty feet in thickness, though this could not be determined for a certainty owing to lack of exposures. This rock in the hand specimen shows a gray and apparently crystalline groundmass thickly studded with deep greenish black very perfectly formed augites and olivines and very numerous minute flecks of brown mica. The augites in extreme cases are ten mm. in length and half as broad; forms five mm. in length are common.

As seen under the microscope and with a power of eighty diameters the rock presents a colorless feldspathic, holocrystalline (?) groundmass, carrying scattering granules of iron ore, numerous greatly elongated dusky apatites, a few small augites, abundant elongated and very irregularly outlined shreds of brown, strongly dichroic mica and the porphyritic augites and olivines above noted. The rock is beautifully fresh and unaltered.

The porphyritic augites show very perfect crystal outlines of the ordinary type; twin forms are rare. Inclosures are minute and limited to what is apparently portions of the groundmass, iron oxides, and mica scales; a faint zonal structure is sometimes apparent. The olivines are also at times in very perfect crystal forms, though more frequently rounded with extremely irregularly toothed or etched outlines closely bounded by small shreds of the brownish mica. This feature is likewise occasionally shown by the augites. The mica itself never shows hexagonal outlines, but is always in very irregular and greatly elongated folia.

The groundmass.—Revolved between crossed nicols no portion of the field remains entirely dark, but breaks up into irregularly bounded areas showing at times an almost granular structure, but more commonly one imperfectly columnar-radiating, the dark wave merging from one portion to another, and in few cases showing crystal outlines sufficiently well defined for determination. Occasional elongated forms show a maximum extinction paralled and at right angles with the axis of elongation. In rare instances still others occur showing twin striæ characteristic of plagioclase feldspars, but beyond this the microscope fails to give satisfactory results. No interference figures are obtainable nor are cleavage lines apparent. An attempt was made at separating the minerals of the groundmass by means of specific gravities, but results were not particularly satisfactory owing to inclosures of mica and iron ores. After repeated attempts a small amount coming down at 2.6 and showing under the microscope no admixture of augites, olivine, or iron ores was obtained, which yielded me on analysis as below.

The determinations were not duplicated, and can be regarded little more than suggestive.

	Per cent.
SiO_2	60.68
Al_2O_3 and Fe_2O_3	21.71
CaO	3.03
K_2O	7.31
Na_2O (by difference)	6.63
	99.36

Evidently a mixture of potash and soda-lime feldspars. A bulk analysis of the rock as made by L. G. Eakins, of the U. S. Geological Survey, yielded the results given in column I, on p. 670.

In the dry ravines and gulches near by, and on the north side of the road leading from Antelope to South Boulder Creek were found obscure outcrops of what from its position was assumed to be the same rock, but which in a state sufficiently fresh for examination could be found only in small rounded bowlders, the main mass of the rock having so thoroughly rotted as to be easily dug out with the hand pick. The freshest nodules obtained showed on a broken surface a deep dark greenish gray indistinctly porphyritic rock in which olivines and augites, with occasional flecks of brown mica, are determinable by a pocket lens. In the thin section this variety is nearly if not quite holocrystalline but its structure badly obscured by decomposition. A clear glassy sanidin intergrown with plagioclase is readily made out, green augites, brown mica, and badly altered olivines.

During a previous season (1886) small outcrops of a somewhat similar rock were found near Cottonwood Creek and east of the Gallatin River in Gallatin County. These on comparison proved to be undoubtedly portions of the same magma, but offer some interesting peculiarities. I find these described as follows in my notes of the winter of 1886–'87:

Macroscopically this rock (No. 38596, U.S.N.M.) consists of a compact aphanitic, dark gray or nearly black, sometimes brownish, groundmass in which are embedded abundant dark green porphyritic olivines and augites of all sizes up to five millimeters in greatest diameter.

Microscopically the rock is both unique and beautiful. In a dense groundmass of a light gray, sometimes brownish color, consisting of a colorless or gray undeterminable mineral, augite microlites, small scales of brown mica, and grains of iron ore, are embedded beautiful large clear grains of olivine and augite, these two minerals alone constituting the porphyritic ingredients.

The olivines occur in clear, colorless, rounded, and irregularly corroded forms, scattered singly or in polysomatic groups, as shown in figure 8, and often in close juxtaposition with the augites. They are beautifully clear and fresh, with but few inclosures of magnetite and

glass cavities. A chloritic or serpentinous alteration has set in and the crystals are traversed by the characteristic irregular canals of bright greenish blue secondary matter and scattering grains of iron ore. The augites occur in sizes fully equal to those of the olivines, and are of a clear light green or faint yellow color in section. They contain very numerous inclosures of the groundmass, a brown dichroic mineral, evidently mica, grains of iron ore, and glass. As a rule, the crystal outlines are far from perfect, the mineral having suffered from the corrosive action of the magma even more than the olivine. The mineral is perfectly fresh and clear, shows sharply developed prismatic cleavages and gives maximum extinctions on clinopinacoidal sections of 43°. Like the olivine, it occurs both in scattered and isolated single crystals and in groups. Twin forms are common after the ordinary type. Augite and olivines often occur in such close juxtaposition as to have mutually interfered in process of growth (see figure 9). So marked an interference between minerals belonging to the earliest stages of consolidation and occurring in widely scattered groups in an unindividualized groundmass can be accounted for only on the supposition that neither mineral is a direct secretion from the magma, but that they are residuals of an earlier crystallization in which consolidation had proceeded so far that free growth was no longer possible. The present rounded, scattered, clustered, or isolated conditions being due to

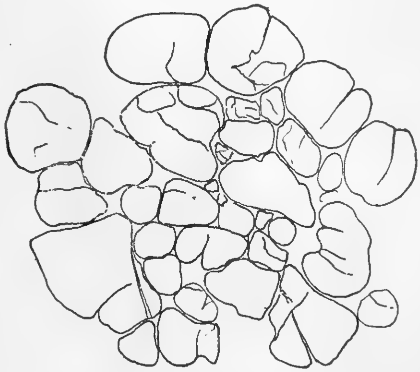


Fig. 8.

POLYSOMATIC OLIVINES.

From specimen No. 38596, U. S. N. M.

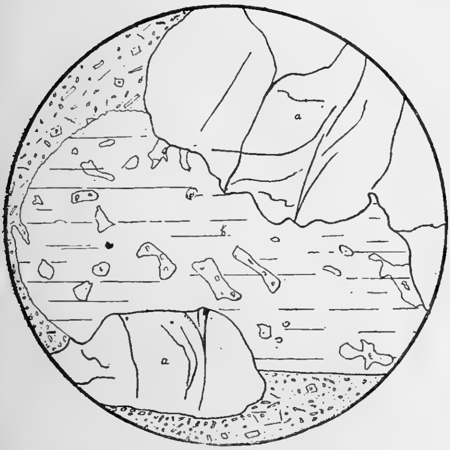


Fig. 9.

INTERGROWN OLIVINES AND AUGITE.

a.—Olivines. *b.*—Augite.

From specimen No. 38596, U. S. N. M.

refusion, such as almost completely destroyed original structures without wholly obliterating the minerals belonging to the first stages of consolidation. The mere rounding alone of either mineral could not be considered as indicative of other conditions than are so frequently shown by those minerals which belong to the earliest generation and which, owing to reelevation of temperature or diminution of pressure have become again partially dissolved by the molten magma. Among crystals which develop freely in a more or less viscid magma, however, no such interference as here shown could have occurred, and we must conclude that their first crystallization took place under more restricted circumstances.

The gray material constituting the greater portion of the groundmass is here not sufficiently crystalline for optical determination. Under a power of 170 diameters it shows only a scaly, granular aggregate of a colorless mineral or minerals, polarizing in light and dark colors, with the individual granules blending into one another as the stage is revolved; often an imperfect, spherulitic structure is developed. The appearance suggested that nepheline or melilite might be one of the constituents, but micro-chemical tests failed to show a trace of either mineral, though an analysis of the portion soluble in hydrochloric acid (p. 670) is very suggestive. From the high percentage of silica and potash shown by the complete analysis it must be inferred that an acid feldspar is a prominent constituent. Occasional areas of colorless glass are seen, but by far the greater part of the groundmass is composed of the white substance, presenting always the peculiar scaly-granular structure above described, and which is unlike anything I now recall, excepting as sometimes displayed in rocks of the phonolite or trachyte groups. Very evenly distributed throughout the entire groundmass are innumerable small flecks of brown mica and augite microlites. These last are peculiarly beautiful and interesting, showing every stage from mere skeleton outlines inclosing areas of groundmass, elongated, needle-like forms with crenate and undulating borders, to quite perfectly outlined crystals.

As shown in the section they are faintly greenish, or nearly colorless. Between crossed nicols the larger forms show cores giving lively bluish or purple polarizations colors, while the borders are very faint yellow.

Although small and imperfect, the optical and crystallographic properties are readily determined, and agree with those of normal augite. No microlites were observed which could with certainty be referred to olivine. The abundant small scales of brown mica are scattered singly and in small clusters quite uniformly throughout the groundmass. It is noticeable, however, that in the immediate vicinity of the corroded augites they often occur in greater abundance, and in particular where augites and olivines lie in close juxtaposition. The space is then often filled with a perfect cloud of the small mica scales, as I have attempted to show in figure 10. I think that there can be no doubt that these, and perhaps all the micas, and augite microlites as

well, result from a recrystallization of the material derived by refusion mainly from the older olivines and augites. The residual augites are not separated from the groundmass by a sharp line, as might be imagined from an examination of the figure alone, but pass into it by slight gradations.

Fig. 10.

CORRODED OLIVINES, AUGITES, AND SECONDARY MICA.

a.—Olivines. *b.*—Augite. *c.*—Mica.

From specimen No. 38596, U. S. N. M.

The above-described minerals, together with small grains of iron ore and innumerable minute, greatly elongated, needle-like crystals of a brownish color, and which occur singly or radiating in every direction from an indefinite nucleus, complete the list of recognizable constituents.

A second variety, found in inconspicuous outcrops a few rods away, was described as follows:

Macroscopically this rock consists of a compact aphanitic groundmass of dark brown color, carrying abundant greatly altered olivines and augites. Under the microscope the groundmass shows a brownish, partially devitrified base, traversed in every direction by innumerable, short, thin, yellowish or brownish flecks of a dichroic mica-like mineral, which are light yellowish when the plane of vibration of the light is at right angles to the axis of greatest elongation and brownish when it is parallel. Between crossed nicols these give maximum extinctions and become almost completely obscured when their longer axes coincide with the plane of either nicol, and are of a light yellowish color at intermediate points. They are too minute and with too imperfect outlines for a more accurate determination of their optical properties, but are undoubtedly of biotite or an allied mica. These flecks, together with innumerable light greenish elongated augite microlites, are so abundant as to form a dense, almost felt-like groundmass, in which are embedded the abundant porphyritic augites and olivines.

As above noted, both these minerals are badly altered though the augite is still shown in a few sections in the form of broad, rounded plates of a light greenish color, with sharply defined prismatic cleavages, and containing very many large inclosures and embayments of the groundmass. The olivine has completely decomposed, and but for the characteristic crystal outlines of the pseudomorphs would be unrecognizable. The product of this decomposition is in part a very light

greenish chloritic substance, and in part a colorless substance so thoroughly impregnated with minute specks of opacite as to give it a bluish hue, remotely resembling hauynite. This secondary substance acts faintly on polarized light, and, being insoluble in boiling acids, is presumably chalcedony. Were it not that the outlines of these pseudomorphs are plainly those of olivines, and the amount of this insoluble substance increases proportionally with the alteration the crystals have undergone, I should hesitate to designate them as olivine derivatives.

Although this rock shows certain structural peculiarities, differing from that just described, I am at present disposed to regard it as a portion of the same flow solidifying, it may be, under slightly different conditions, and having undergone greater changes since its eruption.

Below are given the results of analyses on the three types indicated, Nos. I and III being by Mr. L. G. Eakins, and No. II by Dr. Chatard, of the U. S. Geological Survey. No. I is the fresh porphyritic variety from South Boulder and Antelope Creek (No. 62409, U.S.N.M.); No. II the variety collected in 1886 from near Cottonwood Creek (No. 38596, U.S.N.M.); No. III the variety found in nodular masses in decomposed material as just described, and No. IV a rock from the Absaroka range, as described by Iddings.*

	I.	II.	III.	IV.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
SiO_2	50.82	*a*51.65	50.03	48.36
TiO_2	.59	.55	.61	1.18
P_2O_5	.20	.21	.42	0.84
SO_3	....	.19	....	....
Al_2O_3	11.44	13.89	14.08	12.42
Cr_2O_3	.03	.80	Trace.	Trace.
Fe_2O_3	.25	2.70	2.92	5.25
FeO	8.94	4.80	6.11	2.48
MnO	.19	.15	.08	0.13
CaO	8.14	4.07	7.46	8.65
MgO	14.01	11.56	10.73	9.36
K_2O	3.45	4.15	2.64	3.97
Na_2O	1.79	2.99	1.46	1.46
BaO	.06	.19	.04	0.29
H_2O	....	1.30	....	5.54
Ign	.58	1.89	3.70	
	100.49	....	100.28	99.93
Specific gravity	2.96			

a An analysis of the portion of No. II soluble in hydrochloric acid subsequently yielded results as follows:

	Per cent.
Soluble	33.42
Insoluble	66.58

The soluble portion yielded:

	Per cent.
SiO_2	41.87
Al_2O_3	9.48
Fe_2O_3 and FeO	16.41
MnO	Trace.
CaO	3.10
MgO	26.79
K_2O	1.06
Na_2O	1.26
	99.97

* The Origin of Igneous Rocks, Bull. Philos. Soc. of Washington, Vol. XII, 1892, p. 169.

The rock, it will be observed, is somewhat anomalous as regards both structure and chemical composition. There is apparently little doubt but that the groundmass is in all cases a mixture of potash and soda lime feldspars, as the microscope showed to be the case in the badly decomposed but holocrystalline variety, and with the possible addition of sporadic nepheline. The most striking feature is, perhaps the high percentage of potash in basic rocks so rich in magnesia. Both on structural and chemical grounds one would at first be inclined to regard the rock as belonging to the leucite, nepheline, or melilite bearing series, but most careful tests have so far failed to establish the presence of either mineral, beyond a possible doubt. If the powdered rock is freed from the iron magnesian silicates by means of the electromagnet, the residual white granules yield crystals of sodium chloride when treated with hydrochloric acid, and minute radiating crystals of gypsum when treated with sulphuric acid. It is probable, however, that these reactions are produced by the presence of zeolitic alteration products which the microscope shows to exist. but the exact nature of which can not be made out.

The underlying syenitic rock (Nos. 73168 and 73169, U.S.N.M.) is a gray to pinkish, finely to coarsely crystalline granular rock, consisting essentially of orthoclase and abundant spangles of black mica readily determinable by the unaided eye, while on closer inspection are seen abundant small deep greenish needle-like crystals of pyroxene. These last in forms not over one mm. broad by ten mm. in length.

In the thin section the rock is holocrystalline granular, and the feldspars so opaque and muddied that their optical properties are quite obscure. They resemble the orthoclases of the older syenitic and granitic rocks. Occasionally plagioclases occur, but which in nearly every instance have gone over into a very light, almost colorless decomposition product, at times almost wholly without action on polarized light and recognizable as a pseudomorphous substance by their sharp crystalline outlines. The mica occurs in broad (five mm.) patches made up of a large number of independent folia, none of which show hexagonal outlines, and also in long (five to ten mm.) spangles radiating in every direction. Under the microscope it is deep smoky brown in color, strongly dichroic, and shows extinction angles measured against the cleavage lines in cross sections as high as 8°. The folia are often crushed, bent, and distorted, and show between the plates inclosures of a finely granular colorless mineral aggregate, the nature of which can not be made out.

The augitic mineral occurs in beautifully perfect elongated forms, sometimes as much as ten mm. in length, as above noted. In the section it is only faintly greenish in color, not perceptibly pleochroic and gives extinction angles, c on $\mathfrak{c}$, as high as 41°. Although the prismatic faces are well developed the terminations, so far as observed, are never perfect but often jagged and full of inclosures or even broken into several disconnected pieces which, though extinguishing simultaneously, are

separated from one another by narrow intervals of feldspathic groundmass. The usual prismatic cleavage is well developed.

Abundant long, needle-like light smoky crystals of apatite and the usual scattering of iron ores are also present. Scattered throughout the slide are numerous irregular, triangular, or occasionally, nearly rectangular areas of a colorless, isotropic mineral, without cleavage and traversed only by an irregular network of fracture lines along which a faintly greenish chloritic alteration had set in. The microscope alone proving insufficient for its exact determination, chemical means were resorted to. The powdered rock, treated on a slide with concentrated hydrochloric acid, shortly yielded abundant cubes of sodium chloride; when boiled with the acid it also yielded a jelly. That the mineral was not nepheline was indicated by its optical properties. A test was therefore made for chlorine by warming the powder in a platinum crucible with sulphuric acid and catching the fumes arising in a drop of water suspended on the underside of a covered glass. Tested with nitrate of silver this drop showed an unmistakably white cloud, proving beyond all doubt the presence of chlorine. The isotropic character of the mineral, together with its gelatinization and property of yielding sodium-chloride cubes with hydrochloric acid, and chlorine by the last test, all seem to point conclusively to a mineral of the sodalite group.

Although I have spoken of the rock as granitic this structure does not hold through all parts of the mass. Certain specimens (No. 38600, U.S.N.M.) from near the upper contact, and from distant outcrops (see p. 645), are fine grained and show in the thin section a groundmass with a pronounced plumose or dendritic structure more nearly like that of the trachytes.

Bulk analysis of this rock (No. 73169, U.S.N.M.) yielded me the results given in column I, below. In column II is shown the composition of a sodalite syenite from Square Butte, Montana, as given by Lindgren.*

	I.	II.
	Per cent.	*Per cent.*
SiO_2	54.15	56.45
Al_2O_3	18.92	20.08
Fe_2O_3	6.79	1.31
FeO		4.39
CaO	3.72	2.14
MgO	1.90	.63
K_2O	8.44	7.13
Na_2O	5.47	5.61
Cl	.42	.43
H_2O	Not det.	1.77
P_2O_5	Not det.	.13
TiO_2	Not det.	.29
MnO	Not det.	.09
	99.81	100.45
Excess		.10
		100.35

* Eruptive rocks from Montana. Proc. California Academy of Science, Vol. III, pp. 45–47.

Assuming that all the chlorine belongs to the sodalite, the above analysis indicates the rock to contain nearly six per cent of the mineral.

The composition of the two rocks just described, and their intimate association even in widely separated areas, are peculiarly interesting in the present state of petrographic knowledge. It is evident that on structural grounds, such may be best classed with the lamprophyres, though they differ from any thus far described in many important particulars. This is eminently true with regard to the more basic one of the two, and it seems impossible to give it a specific name without coining one entirely new, a proceeding which, in my present frame of mind, is quite objectionable. Considered as a lamprophyre it would seem to stand distinct from the monchiquites as described by Prof. Rosenbusch,* in the presence of a feldspathic rather than a glassy base, though such a distinction can scarcely be considered an essential, since such might result from merely slight differences in rates of cooling. On purely chemical grounds it is further separated from this group by the high percentages of silica and magnesia, and the fact that the potash preponderates over the soda. From other members of the lamprophyre group, as described by Chelius,† Goller,‡ J. F. Williams,§ Harker,|| Doss,¶ and others, it differs in equally important particulars. Its closest homologue so far as shown by existing literature, appears to be among the rocks forming the "exceptional dikes and flows in the Absaroka range" of Wyoming, as described by Iddings, and to which reference has been made above. These are regarded by Professor Iddings as forming a part of a series "grading into the normal basalt of the region." So far as the Boulder Creek locality is concerned, there is nothing to suggest any such transition. It is, however, very probable that a further comparison of these with the rocks of Fort Ellis (p. 641), Cottonwood Canon (p. 666), Flathead Pass (p. 643), and Horse Shoe Bend (p. 649) might throw more light on the subject. Their general similarity in composition as well as association is certainly very suggestive.

At South Boulder the eruptives occur in the form of successive sheets of which the lower is a compact hornblende andesite which is succeeded by a semiglassy hypersthene andesite, and this, in its turn, by basalt followed by a small sheet of rhyolite.

* Min. u. Pet. Mittheilungen, 1890, p. 445.

† Neues Jahrbuch für Min., etc., 1888, II. Band, 1. Heft, p. 67.

‡ *Ibid.*, 1889, VI. Beilage-Band, p. 485.

§ Vol. II, Ann. Rep. Arkansas Geological Survey. 1890.

|| Geological Magazine. May, 1890, p. 199.

¶ Min. u. Pet. Mittheilungen, XI. Band, 1. Heft, p. 17.

SCIENTIFIC RESULTS OF EXPLORATIONS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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No. XXXIV.—REPORT ON MOLLUSCA AND BRACHIOPODA DREDGED IN DEEP WATER, CHIEFLY NEAR THE HAWAIIAN ISLANDS, WITH ILLUSTRATIONS OF HITHERTO UNFIGURED SPECIES FROM NORTHWEST AMERICA.

By WILLIAM HEALEY DALL,
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IN THE latter part of 1891 the *Albatross* was engaged in making soundings between the coast of California and the Hawaiian Islands, with the intention of obtaining a profile of the sea bottom for use in connection with plans for laying a submarine telegraph cable. This work was performed as rapidly as possible, and no delays made for dredging or other work not strictly germane to the purpose of the voyage until on approaching Honolulu the archibenthal plateau about the islands was reached, and here, in between 300 and 400 fathoms, eight hauls of the dredge were made, of which a table follows. Half a dozen small bottles, containing mollusks and brachiopods, were received in 1892, and the following account of their contents leads us to regret that more time could not have been devoted to dredging.

The material obtained is not only very interesting, zoologically, but wholly new, not a single species heretofore described, either from the deep sea or from the Hawaiian Archipelago, being found among the dredgings. A new subgenus of Pleurotomidæ, the hitherto unknown and very interesting soft parts of a species of *Euciroa*, regarded as belonging to the Verticordiidæ, but now necessarily raised to family rank, several new Brachiopods, etc., are among the material secured, and described in the following pages. To these are added a few new species from the northwest American coast, and a number of species described briefly without figures in 1891 are now suitably illustrated.

Table of stations of U. S. Str. Albatross, near the Hawaiian Islands, December 3 to 6, 1891.

Station.	Latitude N.	Longitude W.	Fathoms.	Bottom temperature.	Character of bottom.
	° ′	° ′			
3467	21 13	157 43½	310	....	Sand.
3470	21 08½	157 43½	343	43.3°	Do.
3471	21 10½	157 48½	337	....	Do.
3472	21 12	157 49	295	....	Do.
3473	21 15	157 30	313	43.8°	Do.
3474	21 12	157 38½	375	....	Do.
3475	21 08	157 43	351	....	Do.
3476	21 09	157 53	298	....	Do.

The "sand" revealed by so much of the bottom as adhered to several of the specimens is wholly composed of organic débris, minute fragments of echinoderms, shells, corals, foraminifera, etc., in which small particles of pearly shell counterfeit the appearance of mica. No mineral matter of a purely inorganic character was detected.

Mollusks were received from all the stations except 3467 and 3470. Station 3476 afforded eight species; station 3475, seven species; station 3472, four species; and the others two species each.

The *Euciroa* was obtained at five stations, one of the Pleurotomidæ at three stations, and the two species of *Dentalium* both occurred at stations 3475 and 3476.

As it seemed desirable to keep together the scanty data belonging to to the Brachiopoda, rather than to scatter them through several papers, the species obtained by the *Albatross* at several stations along the eastern border of the Pacific, have been included with the others in treating of that group.

Class GASTROPODA.

Genus SCAPHANDER Montfort.

Section BUCCONIA, Dall.

SCAPHANDER ALATUS, new species.

Plate XXVII, fig. 2.

Shell pure white, with a pale straw-colored epidermis, polished, punctate, with a pervious axis; sculpture of faint lines of growth crossed by numerous fine rows of punctures, with wider, pretty regular, interspaces; behind the pillar-lip a few of these rows are so impressed as to form grooves; form of the shell ovate, attenuated in the posterior third; aperture as long as the shell, narrow behind, rounded in front; outer lip sharp, produced behind the immersed spire in an alate manner; body with a thin wash of smooth pure white callus; pillar lip twisted about a pervious axis, stout, thick, with a narrow groove behind its anterior part, but no umbilical chink. Extreme length of shell 35, maximum diameter 20 mm.

Station 3476, in 298 fathoms. No. 107161, U.S.N.M.

This species belongs to the section *Bucconia*, Dall. It is nearest allied to the type of that section, *S. nobilis*, Verrill, from which it may be at once discriminated by its more attenuated posterior third and generally thicker shell and less inflated form, and by its alate outer lip. The gizzard plates are somewhat less distinctly quadrate than in *S. nobilis*. The *Challenger* obtained west of Papua a species of this group, *S. mundus*, Watson,* which is very like *S. nobilis*, but can not be confounded with the present species.

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* Challenger Gastr., pl. XLVIII, fig. 2.

Subgenus SABATIA, Bellardi.

SABATIA PUSTULOSA, new species.

Plate XXVI, fig. 10.

Shell solid, large, subpyriform, with wholly immersed spire and granular callous body lip; surface polished, sculptured by deep, rather wide, channeled grooves; punctate, but with the punctures overlapping one another so that the line presents an annulate aspect. There are a few intercalary, fine impunctate lines also. The form of the shell is rather rounded, smaller posteriorly, with an obscure constriction about the middle of the shell; apex dimpled, but imperforate; aperture narrow behind, wide and rounded in front; outer lip thin, raised above the apex, but hardly alate; inner lip thick, callous, with numerous pustules, the axis barely pervious; pillar thick, pustular, its outer edge high, with a groove behind it, but no umbilical chink. Extreme length of shell, 33; maximum diameter, 20 mm.

Station 3472, in 295 fathoms, one dead and discolored specimen. No. 107012, U.S.N.M.

This species recalls the more inflated *Scaphander niveus*, Watson, from near the Philippines, but is readily distinguished by its more attenuated *Bulla*-like form. It may, when older, exhibit a more prominent body callus than is shown by our specimen, the granulation of the pillar being much like that of adolescent specimens of *Sabatia bathymophila*, Dall, from the deeper waters of the Antilles.

Genus PLEUROTOMA, Lamarck.

PLEUROTOMA (DRILLIA) MICROSCELIDA, new species.

Shell with six or more whorls (all the specimens decollate), solid, white, with an ashy pale-brown epidermis; aperture less than half the length of the shell; suture distinct, not channeled; anal notch rather anterior, about as deep as wide, separated from the suture behind by a somewhat excavated area; spiral sculpture of, in front of the suture, a plain, strong thread, in front of that three or four anteriorly diminishing threads; the anal fasciole, contrary to the ordinary rule, projects, showing two small distinct adjacent threads, which overrun and somewhat nodulate numerous short abrupt peripheral wavelets; in front of the fasciole three strong alternate with three feeble revolving threads, and still in front of these six or eight small threads occupy the base; the siphonal part is decorticated. The transverse sculpture is composed of the peripheral wavelets before alluded to, which are rather close set and about 21 in number, on the penultimate whorl; there is no other transverse sculpture except lines of growth, which are not very prominent; aperture narrow, with a relatively wide canal; pillar solid, slender, and somewhat twisted; body not callous, and with no subsutural callosity; interior of aperture not lirate; length of five (decollate) whorls,

22; diameter of shell at posterior end of aperture, 8.5; length of aperture, 9 mm.

Station 3475, in 351 fathoms. No. 127122, U.S.N.M.

This species has somewhat such a sculpture as the Antillean *P. periscelida*, Dall, which is a much larger shell, and not a *Drillia*. The most closely allied form I have seen is one dredged in 50 fathoms in the harbor of Unalaska by the *Albatross*, but the latter is a shorter and stouter and probably a smaller shell when adult. The specimens of *P. microscelida*, though alive when collected, were much eroded, so that the description has been made up from the patches of uninjured surface. By an accident to the jar the alcohol had evaporated, and only the shell remained when received, so that nothing can be said as to the soft parts. It is probable, however, that the species should be referred to the genus *Drillia*.

Genus MANGILIA, Risso.

Subgenus PLEUROTOMELLA, Verrill.

PLEUROTOMELLA GYPSINA, new species.

Plate xxx, fig. 10.

Shell small, subfusiform, moderately thick, white, covered with a well-marked, unpolished brown epidermis; whorls six beside the (decollate) nucleus, rapidly increasing; aperture slightly exceeding half the total length; suture distinct, but not channeled or marked by any elevated thread; upper portion of the whorl, directly in front of the suture, somewhat excavated, forming a wide anal fasciole; spiral sculpture of, near the suture, fine, low, flattish, close-set threads, which, beyond the fasciole, are gradually more and more distant until, near the canal, the interspaces are thrice as wide as the threads; the sculpture, as usual, is stronger on the upper whorls; transverse sculpture of fine, even lines of growth, and (on the last whorl about 26) small, distinct, even, very oblique ribs, with slightly wider interspaces, beginning strong, but hardly nodular at the anterior edge of the fasciole, and becoming obsolete on the base; on the upper whorls they reach the suture; the last whorl is much the largest, the aperture and canal rather wide, the anal notch arched and shallow, the outer lip projecting below it; pillar lip but slightly callous, interior of the aperture smooth; pillar straight, attenuated in front, the canal obliquely cut off in front. Length of the shell, 23; width at the posterior angle of the aperture, 8.5 mm.

Station 3475, in 351 fathoms. No. 107015, U.S.N.M.

The single specimen is a good deal eroded and has lost its nucleus. The species is not unlike *P. gypsata*, Watson, from 700 fathoms near New Zealand, but that species has only fifteen ribs, which do not reach the suture on the earlier whorls. There are no remains of the soft parts, but the shell looks like a small *Pleurotomella*.

PLEUROTOMELLA HAWAIIANA, new species.

Shell small, subfusiform, solid, polished, grayish white, with five or more whorls; suture distinct, the whorl in front of it somewhat excavated and appressed; spiral sculpture present only on the base, where it is faint, and on the pillar, where it is coarser, and composed of obscure close-set spiral threads; transverse sculpture near the apex of a few wrinkles, which are visible on the upper part of the anal fasciole, beginning at the suture, but these do not persist; the lines of growth are not generally perceptible without a glass; on the shoulder of the whorl are (on the last whorl about 17) numerous short oblique riblets with equal or wider interspaces, little raised, almost like nodules on the last whorl, but near the apex of the spire they are straighter, and extend from the anterior border of the fasciole to the suture, gradually becoming feebler as the shell grows; aperture rather narrow, the anal notch quite deep, reaching the suture above, while the lip below is produced forward; the pillar is stout and strong, the canal straight and rather shallow; length of (decollate) shell, 13; diameter of the last whorl at the posterior angle of the aperture, 5; length of last whorl, 10 mm.

Station 3475, in 351 fathoms. No. 107020, U.S.N.M.

This shell recalls *P. chariessa*, Watson, but is much smaller and relatively much more solid; the wrinkled subsutural band is absent and the shell is smoother. *P. chariessa* is an Atlantic species, as far as yet known. The single specimen obtained is somewhat broken; the form of the outer lip is described above from the lines of growth. The nucleus and probably a whorl or two more have been lost from the tip of the spire.

? PLEUROTOMELLA CLIMACELLA, new species.

Plate XXXI, fig. 14.

Shell slender, small, of five or more (decollate) whorls, covered with a pale straw-colored epidermis, underneath which the shell is porcellanous or chalky white; form elongated, slightly constricted in front of the suture, which, especially in the earlier whorls, is bordered by a somewhat irregular nodulous elevated thread; spiral sculpture of subequal flattened threads, with wider, irregular interspaces; these threads are coarser and more distant near the canal, and absent on the anal fasciole; transverse sculpture of irregular, often prominent, lines of growth, and thin, sharp, low, narrow, irregular riblets, with much wider interspaces, more prevalent on the earlier whorls and more or less obsolete on the last; these ribs tend to nodulate the shoulder and sutural thread when present; aperture less than half the length of the shell, rather narrow, with a wide, short canal, which is not, or but slightly, recurved; pillar lip not callous, pillar obliquely truncate in front, rather stout above; outer lip thin, not reflected, the anal notch almost obso-

lete. Length of the shell (decollate), 18.5; diameter at the posterior angle of the aperture, 6; length of the aperture, 8.5 mm.

Station 3475, in 351 fathoms. No. 127123, U.S.N.M.

Two somewhat eroded specimens were obtained, one of which contained the dried remains of the animal, which could not be extracted. There was no trace of any operculum, and the species can not therefore be referred to *Bela*, while it lacks the deep sutural sinus of *Daphnella*. Its resemblance to certain Atlantic species of *Pleurotomella* is sufficient to indicate the systematic place it should probably occupy.

The species is near *Bela climakis*, Watson, but has a proportionally longer aperture and larger last whorl. It is quite likely that Watson's species should be referred to the same group. *Clionella quadruplex*, Watson, is nearly allied by the shell characters.

SPERGO, new subgenus.

Shell large, thin, nearly destitute of sculpture, with an unrecurved pillar, a short, wide, straight canal, a wide shallow emargination representing the anal notch, and generally feeble anal fasciole, except in the very young; a sharp outer lip, unarmed aperture, and *Sinusigera* nucleus.

Animal with the muzzle formed by a stout squarely truncated rostrum opening into a capacious pharynx, provided internally with a degenerate proboscis not capable of extrusion beyond the oral orifice, with a poison gland and a degenerate radula. Eyes present and functional; tentacles low-seated, stout, and clavate; operculum absent; dentition resembling that of *Bela*.

This form resembles *Pleurotomella*, Verrill, from which it differs in the character of the rostrum and pharynx, in the possession of eyes, in its straight wide canal, and in having a feebler type of verge, anal notch and fasciole.

SPERGO GLANDINIFORMIS, new species.

Plate XXIV, figs. 1, 2.

Shell large, slender, glandiniform, with a typical brown *Sinusigera* nucleus of three and a half whorls, followed by eight normal whorls; color pale madder brown, more or less zoned in harmony with lines of growth, and with a peripheral and basal spiral paler band feebly indicated; the pillar in the young stained with a darker brown, or pinkish white in the full-grown shell; spire rather pointed, the apical whorls sculptured with incised spiral grooves below the shoulder and with numerous small oblique riblets over which the grooves run; the space between the shoulder and the suture behind it slightly impressed, smooth, or crossed by distant low sharp wrinkles, very narrow and not corresponding to the ribs. All this sculpture becomes rapidly obsolete, and on the greater part of the shell the sculpture is confined to silky

lines of growth, faint traces of obscure spiral lines, and a few feeble narrow threads on the base and canal under a pale thin epidermis. The last whorl is compressed at the periphery, as in *Glandina parallela*, giving the body whorl a subcylindric aspect; suture appressed; aperture long, rather narrow, internally smooth, and with very little callus on the pillar or body; outer lip sharp, emarginate before and behind and arched forward in the middle; pillar obscurely thickened behind, attenuated anteriorly, as long as the canal, straight, but slightly twisted; canal and anal emargination wide and shallow; length of an adult, 75; of the aperture, 45; width of the shell at the posterior angle of the aperture, 20 mm.; length of the figured specimen, 45 mm.

Stations 3471, in 337; 3474, in 375; and 3476, 298 fathoms, southeast of Honolulu. Nos. 107013, 107019, and 107160, U.S.N.M.

The animal is of a yellowish color, the columellar muscle attached very deeply within the shell. The foot is strong. In the alcoholic specimen it is transversely wrinkled below, wrinkled and more or less granose at the sides above, the posterior end obtusely pointed; anteriorly it is wider, with the lateral angles produced and the anterior margin double. The rostrum is quite peculiar, dilate, and squarely cut off at the end, which exhibits a flat, circular face concentrically wrinkled, with a very large rounded mouth, the edge of which is deeply radially wrinkled, giving it a papillose aspect externally. The horizontal line joining the bases of the tentacles will pass below the central axis of the rostrum, which is also distinctly constricted behind the tentacles. The surface of the rostrum is smooth, its dorsal line arched. The tentacles are short, stout, transversely wrinkled, and distinctly larger distally. There is a slight enlargement near their bases, where a small, black-pigmented eyespot is clearly visible on both. There is no trace of an operculum or opercular lobe, nor any epipodial processes. Raising the mantle, which has a slightly thickened, smooth edge, we find, rather far back, the verge, which consists of a rather stout, recurved basal portion, above which it is constricted, the remainder being more slender, subcylindrical, slightly enlarged distally, but beyond this tapering to a point. The organ is smaller in proportion to the size of the animal than in most Pleurotomidæ. Above, on the dome of the mantle, is attached the rectum, with an evenly tapered adherent termination and a longitudinally wrinkled subcylindrical lumen. To the left of this the muciparous gland and kidney cover a broad strip of the mantle. Farther to the left we find a ctenidium composed of a single series of leaflets of the ordinary type, succeeded on the left by a well-developed Sprengel's organ, as usual, of a dark-olive color. The siphon, which is closely adjacent, is of very substantial tissue, with an external tinge of olive brown. It presents nothing unusual.

Internally the anatomy offers several points of interest. Within the oral orifice is an immense "crop" or pharynx (22 mm. long in the specimen examined), which, from the deep longitudinal wrinkles of its sur-

face, is evidently capable of being greatly distended. It has a smooth, rather tough, lining without any horny appendages, and is lubricated by the discharge of several muciparous glands of rather small size. Its inner end is abrupt, and at the left of the middle line is the opening of the œsophagus, very much smaller than the pharynx in diameter. The proboscis proper is very short (in spirits), only about one-sixth as long as the pharynx, and therefore, unless capable of great extension in the living state, probably can not be extruded from the oral opening. The pharynx of the specimen examined was partly filled with a dark-greenish matter, apparently of a mucous character, which showed no traces of organization, leading to the supposition that the pharynx was adapted to the engorgement of large masses of protoplasmic matter rather than the pursuit of living animals of a higher order, as in most *Toxoglossa.* The modification is analogous to that by which *Turcicula*, a derivative from a phytophagous stock, has become adapted to gorging itself with large quantities of foraminifera, algæ being absent from its habitat. The tooth sac opens near the end of the proboscis, but being filled with coagulated mucus, and extremely reduced in size by degeneration, could not be discovered until the mass was boiled in caustic potash in the hope of finding some traces of teeth.

The teeth are set regularly in a single row on each side of an epithelial strip of rather horny (not chitinous) consistency, the points of the teeth inclined obliquely inward and overlapping a little. The width of the radula from base to base of the opposite teeth is $\frac{1}{125}$ of an inch. The length of the developed radula is about $\frac{1}{20}$ of an inch. There are forty or more developed teeth in each row, besides ten or twelve undeveloped germs of teeth. The fully developed teeth are $\frac{1}{200}$ of an inch in length and about one-fourth as wide as long. This, for a creature over 4 inches long when extended, seems very minute. The form of the teeth is much like that of *Bela;* they are sharply pointed, translucent, and composed of a plate like the die for a steel pen folded closely upon itself with a U-shaped section. The shaft is set in a chitinous yellow socket, which is extended on the back of the tooth so as to form a little hooked knob; opposite this many of the teeth show a small sharp basal denticle. The anterior arm of the U is shorter than the other and obliquely trimmed off toward the apex of the fang. There is a well marked oval poison gland, about 2.5 mm. long, with a slender duct folded twice upon itself, very tortuous, and about 15 mm. long. Behind the proboscis the alimentary canal continues of moderate size for nearly a whorl, when there is an inconspicuous enlargement corresponding to a stomach, with its inner walls longitudinally wrinkled and no marked pyloric curve. It contained merely mucus, and resembled a slight enlargement of the esophagus rather than a well differentiated stomach.

The upper portion of the animal could not be extracted from the spire in spite of all efforts, and so great an advantage in this respect is

given by the deep insertion of the columellar muscle, I was unable to withdraw any part of the animal in good condition until after cutting into the penultimate whorl with a file and severing the muscle with a fine scalpel. This is a very interesting form, evidently related to some of Verrill's *Pleurotomellæ*, but differing in important respects as may be seen by the generic diagnosis. It should be remembered that Verrill's type is *P. packardi*, which differs considerably from most of the species afterwards referred to the group. An examination of specimens of *Pleurotomella agassizii*, Verrill, showed that the oral opening in that species did not markedly differ from other species of *Pleurotomidæ* and the tentacles were eyeless and cylindrical. The specimen being a female, the forms of the verge, which often offer good characters, could not be compared, but Verrill describes it in *P. packardi* as "very large and long, round, nearly cylindrical, except near the tip, where it tapers; in alcoholic specimens it is nearly as thick as the neck, from which it arises."* It will be observed that this description does not accord closely with the characters in *Spergo*.

The shell figured is a young one with uneroded apex. It is less than half the size of the largest collected, but was chosen for figuring because it showed the characters more clearly.

SPERGO DAPHNELLOIDES, new species.

Plate XXXI, fig. 11.

Shell small, thin, polished, with a pointed *Sinusigera* nucleus of three and a half whorls and six subsequent whorls; nucleus bright yellow brown, often caducous, leaving the white internal callus to represent it, which being molded on the interior of the nuclear whorls, is polished and smooth, while the original nucleus has oblique reticular curved sculpture; sculpture much like that of *S. glandiniformis*, but having the whorls appressed at the suture lower on the antecedent whorl, the riblets more prominent, less oblique, and higher on the whorl, the fasciole more deeply impressed and its sculpture indicating a deeper sinus, and the fine spiral grooving continuous and uniform over the whole surface of the shell; whorls rounded, the last inflated with the outer lip greatly produced, as in *Daphnella*, and the sinus pronounced; pillar straight, brown tinted, canal shallow, narrow; outer lip thin, smooth and glassy within, sharp edged. Length of shell, 23; width at the periphery of the last whorl, 10; length of last whorl, 17.5 mm.

Station 3476, in 298 fathoms. No. 107015*a*, U.S.N.M.

Two specimens of this pretty little shell were obtained, which have so much the general color and surface of *S. glandiniformis*, that at first they were passed over as the young of that species. When both came to be studied carefully it was evident at once that they were distinct. The present species is more acute, more drawn out in coil, and more

* Verrill, Trans. Conn. Acad., v, p. 454.

rounded than the young of the other, and has none of its cylindrical appearance.

The soft parts resembled those of *S. glandiniformis*, though the rostral disk was less conspicuous, but the eyes were very large and black, and the tentacles placed low on the side of the head, as in that species. The angles of the anterior edge of the foot were markedly produced.

It seems not unlikely that *Daphnella limacina*, Dall (*Pleurotoma* (*Defrancia*) *hormophora*, Watson), from the deep water of the North Atlantic, may be referable to the subgenus *Spergo*, as there is much similarity in many of the conchological characters, as well as the absence of an operculum and the presence of eyes.

Genus POLYNICES, Montfort.

Subgenus LUNATIA, Gray.

LUNATIA SANDWICHENSIS, new species.

Plate XXVI, fig. 8.

Shell small, thin, white, with a thin straw-colored epidermis and about five whorls; surface polished, with faint spiral markings and fine delicate lines of growth, which, between the shoulder of the whorl and the suture behind it, are irregularly elevated into fine, sharp, oblique wrinkles; suture appressed with a faint spiral impression in front of it; form recalling in miniature that of *Natica russa*, Gould, or *N. clausa*, Broderip; whorls well rounded, slightly flattened in front of the suture; aperture with a moderate callus on the body reaching, but not obscuring, a narrow deep umbilicus. Height of shell, 15.7; maximum diameter, 15 mm.

Station 3476, in 298 fathoms, one dead specimen. No. 107017, U.S.N.M.

Though this modest little species has no very marked characters, I have compared it with all our deep-water species described or inedited, and find none with which it can be united. The wrinkles are an interesting feature, as they recall the grooves or wrinkles so frequently found on typical species of *Natica;* but the umbilical characters show that it must be referred to *Lunatia*, in the vicinity of *L. grönlandica.*

Genus MARGARITA, Leach.

Subgenus SOLARIELLA, A. Adams.

SOLARIELLA RETICULINA, new species.

Plate XXVI, fig. 9.

Shell thin, frosted-pearly white; depressed-conic, with a (lost) nucleus and five subsequent whorls; suture inconspicuous, appressed, undulated by the sculpture of the whorl upon which it is applied; sculpture of the spire very uniform, spiral sculpture of (on the upper whorls two or three and on the last whorl five) sharp, narrow, spiral ridges increasing

in strength peripherally, and with much wider interspaces; on the base are five more beside the umbilical carina. The peripheral ridge is the highest and the suture is applied against it, the interspace below the peripheral ridge is a little wider than the others; on the spire the transverse sculpture comprises numerous obliquely radiating short ridges which cross the spirals at regular intervals and extend more than half way across the adjacent interspaces; these radii are not continuous over any two spirals but alternate on the successive single spiral ridges, rising to a sharp point where they cross, the upper series beginning close to the suture; on the base the umbilical carina is marked by a strap-like flat rib across which lie close-set rectangular knobs from which radii extend continuously or nearly so to the outer basal spiral, with an intercalary set of radii appearing somewhat irregularly as the interspaces widen toward the periphery; inside the wide scalar umbilicus the radii are continued as vertical, close set liræ, only interrupted by an obscure spiral ridge just below the internal sutural line; aperture oblique, subquadrate, crenulated by the sculpture, the margins sharp and thin, the body with a thin wash of callus, the throat pearly and smooth where not angulated by the sculpture; the pillar lip not differentiated; epidermis pale straw color, extremely thin with a slightly silky luster; height of shell, 7; maximum diameter, 10; minor diameter, 8 mm.

Station 3475, in 351 fathoms; temperature 43° F. No. 127121, U. S.N.M.

The sculpture is something like that of *Trochus illotus*, Watson,* but the form of the shell is different. It belongs to the group of *T. æglees* Watson and *Solariella actinophora*, Dall.

Genus EMARGINULA, Lamarck.

EMARGINULA HAWAIIENSIS, new species.

Plate XXVI, fig. 7.

Shell large, thin, recurved conical, slightly wider behind than in front; of an ashy cream color, but probably white when fresh; nucleus lost; apex small, recurved, pointed, somewhat laterally compressed; anterior slope gently arched; posterior slope straight or possibly a little concave, shorter than the anterior; outline of the base evenly rounded; sinus narrow, one-fourth as long as the whole anterior slope, set in to the right of the middle line of the shell, its limbs tending to approach anteriorly; fasciole narrow, marked by close-set semicircular elevated ripples, concave forward; sculpture of close, even, regularly distributed, elevated threads, radiating from the apex with smaller intercalary threads toward the margin; these are crossed by even, regular, elevated concentric lamellæ, slightly nodulous at the intersections; at the margin of the shell the major radials are slightly more than a millimeter apart

* Challenger Gastr., pl. XVII, fig. 3c.

from center to center; in the other direction there are about three concentric lamellæ to a millimeter; interior of the shell smooth; an obscure impressed rib marks the course of the fasciole; the margin is slightly radially grooved in harmony with the external radial sculpture. Length of the base, 23; width, 17; height of the shell, 11 mm.

Station 3473, in 313 fathoms. No. 107011, U.S.N.M.

This species has a good deal such sculpture as *Cranopsis asturiana*, Fischer, but the latter has the radii and concentric lines less elevated. On the plane of the base the apex is 17 mm. behind the anterior margin. Only one dead specimen was obtained.

Class SCAPHOPODA.

Genus DENTALIUM, Linnæus.

DENTALIUM PHANEUM, new species.

Plate XXVI, fig. 1.

Shell rather thin, pale straw color, glistening, nearly straight, the curve chiefly in the earlier third; the shell originally is smooth or with few, feeble elevated lines, which in traversing the distance from the apex to the aperture revolve one-fourth of a turn to the right; surface marked by delicate annular lines of growth and longitudinally by about twenty-five very fine, sharp, little-elevated threads, which are strongest about the middle of the shell and more or less obsolete in front and behind; between these are faint obscure longitudinal striæ; both orifices of the shell are simply circular, the anterior sharp-edged and a little oblique. Length of the shell, 35; anterior diameter, 2.2; apical diameter, 0.5; maximum deviation of the curve from a chord drawn between the ends, 3.2 mm.

Stations 3475 and 3476, in 351 and 298 fathoms. Nos. 107025 and 107026, U.S.N.M.

This species is perhaps most nearly allied to *D. antillarum*, Orbigny, of the Antilles, a species which differs in its sharper and more numerous ribs, which become more prominent toward the apex instead of obsolete. Of Pacific species *D. numerosum*, Dall, a form which occurs in very deep water from the Galapagos to California abundantly, has the most general resemblance to the present species; but it grows to nearly twice the length, and when closely examined is seen to have a sharply pentagonal posterior section with a conspicuous ventral slit. *D. numerosum* is a somewhat straighter and longer shell than *D. phaneum*.

DENTALIUM COMPLEXUM, new species.

Plate XXVI, fig. 3.

Shell large, solid, thick, normally white (?), but discolored by sediments after death, so that the specimens received are a pale, rusty brown; surface glossy, sharply grooved, with wider flat interspaces, varying finer or coarser in different specimens; orifices circular, one

specimen showing indications of a wide, shallow ventral sinus at the apex; shell little curved, and the sculpture shows no rotary tendency. Length of shell, 78; diameter anteriorly, 8.5; posteriorly, 1.3; maximum divergence from a chord connecting the extremities, 8.5 mm.

Stations 3472 and 3476, in 295 and 298 fathoms. Nos. 107022 and 107023, U.S.N.M.

This shell differs from *D. candidum*, Jeffreys, by being more cylindrical and, so far as my present specimens go, without the long, slender ventral slit of that species. From *D. ceras*, Watson, as figured, it is distinguished by being straighter and less sharply sculptured, besides being much larger, but Watson's specimens were young. With a few specimens it is easy to separate species of *Dentalium*, but if one has numerous specimens from various kinds of bottom the difficulty increases greatly. *D. solidum*; Verrill; *D. ceras*, Watson, and *D. candidum*, Jeffreys, appear to merge into one another, yet individual specimens appear very distinct when one has not a connecting series. The present species, by its somewhat more cylindrical form, seems sufficiently distinct to be named, but, with that exception, is very closely related to the group of forms above enumerated.

All the specimens were dead, discolored, and occupied by annelid tenants.

Class PELECYPODA.

Family EUCIROIDÆ.

Genus EUCIROA, Dall.

When first proposed,* this group was supposed to be sufficiently distinct from *Verticordia* as defined in the text-books, but later † a careful study of numerous species of *Verticordia*, including the type species of that genus, led to the belief that it could at most form a section of the older group, and as such it was included in my final report. ‡ It was only known from separated valves of the type species *V.* (*E.*) *elegantissima*, Dall, dredged in 300–750 fathoms in the Antilles. Since then a related and very elegant species has been dredged in the Indian Ocean by the *Investigator*, and has been described § by Wood-Mason and Allcock under the name of *Verticordia* (*Euciroa*) *eburnea*. ||

I have now the pleasure of adding a third and very beautiful species from the Pacific, which, being taken with the soft parts intact, enables me to complete my description of the group and establish it as even more than generically separate from the typical *Verticordia*.

* Bull. Mus. Comp. Zool., v, pp. 61, 62, 1878.

† *Op. cit.*, IX, p. 106, 1881.

‡ *Op. cit.*, XII, pp. 196, 291, Sept., 1886.

§ Ann. Mag. N. H., Dec., 1891, p. 447, fig. 14.

|| Sowerby, overlooking this description and figure, redescribed this species under the name of *V. optima* in Proc. Mal. Soc., Lond., I, p. 39, pl. V, fig. 3, Mar., 1894.

It may be well to recall here the essential characters of the anatomy of the *Verticordia acuticostata*, the type of that genus. It has two siphonal openings with their orifices fringed with several rows of papillæ; the anal siphon opens into a closed chamber, the floor of which is formed by a muscular fleshy septum imperforate except for the passage of a short, stout, stopper-like foot, around which the septum fits closely; the lower surface of this septum is devoid of any appendages; on each side of the foot lies, adnate upon its surface, a small elongate triangular gill resembling one of the oral palpi of ordinary pelecypods, but separated by some distance from the oral aperture. This gill is without doubt functional as a ctenidium, but may be homologous with the posterior palpus (a view suggested by the presence of palpi in *Euciroa*), a possibility which requires further investigation; at all events no other organ (unless it be the general surface of the septum and branchial chamber) is present for purposes of respiration. There are no palpi about the mouth. The edges of the mantle are separated only by a narrow opening sufficient to give passage to the foot. The septum was homologized by me with the siphonal septum of ordinary pelecypods, which was supposed to be extended forward to the visceral mass as it is in *Lophocardium*, though in the latter genus the usual functional gills are present.

In *Euciroa* the following differences may be noted: The opening between the lobes of the mantle is ample, the foot laterally compressed, though small, more nearly resembles the same organ in the average pelecypod; both pairs of labial palps are present and free; while a septum exists, the posterior part of which is obviously formed by an extension forward of the siphonal septum, yet a large part of it is formed by lamellar gills which extend backward from the visceral mass near the mouth enclosing the foot, and have their edges connected with each other on each side and with the tissue of the mantle laterally, so that, as in *Verticordia*, a complete separation between the anal and the branchial chamber is insured. These differences, which will be described in full detail under the species about to be named, are quite sufficient to justify the assignment of generic rank to the group separated by me under the name of *Euciroa*.

EUCIROA PACIFICA, new species.

Plate XXIII, figs. 2, 4; plate XXIV, figs. 4, 5, 7, 8.

Shell rounded, inflated, solid, brilliantly pearly within, of a frosty dull white externally, covered with a very thin pale brownish epidermis, under which the shell is everywhere minutely granular and sculptured with fine radiating lines of large, sometimes sharp-pointed and recurved, granules, the rows being very close set posteriorly but with wider interspaces toward the middle and anterior part of the valves; concentric sculpture only of feeble incremental lines, visible chiefly near the basal margin of the valves; beaks prominent, full, much incurved, anteriorly

twisted; in the young shell a prominent thread radiates from the beak, setting off a posterior area over which the granules do not have a distinct linear arrangement, but as the shell grows this thread becomes obsolete, though the difference in the distribution of the granules continues; internal surface of the valves polished, pearly, with obscure radiating and some vermicular impressions, the internal margin of the valves finely grooved radially; muscular impressions small, somewhat obscure, the posterior larger; external ligament thin, short, hardly functional; internal resilium short, strong, set obliquely under the dorsal margin and reenforced below by a calcareous lithodesma, thick, deltiform, rounded below with a short, pointed process on each side behind; there is a small, nearly smooth, deeply impressed lunule mostly attached to the right valve, the margin here projecting, while in the left valve a similar projection is so depressed as to pass for the most part below the projection of the right valve and perform the function of an anterior lateral tooth; the left valve behind the beak shows a long, almost linear, depression, which must be taken as the escutcheon, the most posterior part of which passes below the margin of the right valve, while on the edge of the latter, close to the resilium, is a small, little-elevated, narrow lateral tooth; in front of the resilium in the right valve is a large, stout, pointed, recurved cardinal tooth arising from the valve under the lunule and hooking into a funicular cavity below the beak of the left valve. Behind this in the left valve is a narrow little elevated cardinal, easily mistaken for a raised edge of the cartilage pit, and serving to defend the lithodesma from pressure by the right cardinal. Using *c* for the cartilage and *l* for the lateral teeth, the Steinmann formula for the hinge would be as follows: $\frac{\mathrm{L}\ l\ o\ c1o\ l}{\mathrm{R}\ o\ l\ co1\ o}$; though the laterals do not enter actual sockets in the opposite valve. Height of the shell, 25; length, 28; diameter, 21 mm. A dead valve reaches a length of 38 and a height of 35 mm.

Stations 3471, 3472, 3474, 3475, and 3476 in 295 to 375 fathoms; temperature between 43° and 44° F. Nos. 107008, 107027, 107028, 107029, 107030, and 107031, U.S.N.M.

This fine species differs from *E. eburnea* by its recurved, smaller, and more delicate and more numerous granules. It is more like *E. elegantissima*, from which it differs in the rounder form of the young shell and in the full grown by its thinner and anteriorly more produced valves. The minor details of the hinge, and the position of the pallial and muscular impressions on the valve also serve, when carefully compared, to discriminate the species.

The soft parts offer several points of interest already alluded to. The tissue, internal to the mantle and external to the viscera, especially on the ventral surface, is remarkably thick, almost jelly-like, and full of connective fibers. The margin of the mantle appears smooth and somewhat thickened by peripheral muscular fibers form-

ing a band; within the margin is a little elevated reduplication of the inner layer, the edge of which appeared to be minutely papillose, and which in life can probably be extended to several times its length as preserved in spirit. In front the lobes are separated in front of the anterior adductor and continue distinct three-fourths of the way to the incurrent siphon, when they are joined; around the oval area occupied by the papillæ about the siphonal orifices the border of the mantle, dividing again, forms a thickened frame which is united in front of the posterior adductor. The sides of the mantle in front of the incurrent siphon—below the middle line of the valves (drawn horizontally) and on each side of the pedal opening forward to the vertical of the anterior adductor—present rounded-triangular areas with their apices anterior, where the tissue of the mantle between the inner and outer laminæ of each lobe is thickened by the presence of a quantity of columnar muscular tissue perpendicular to the surfaces of the laminæ and very uniformly distributed. These areas are crossed by numerous branches (more or less bifurcated) given out by the pallial nerve, and the outer face of the area thus modified is attached to the valve, upon which it leaves somewhat vermicular surface markings.

Several longitudinal or radiating fibers or bands parallel to the surface of the mantle are also observable by transmitted light, the chief of which extend toward the base of the incurrent siphon or in the direction of the anterior adductor. These masses of muscle have no obvious function; they occupy the area of the radiating retractors of the siphons in ordinary *sinupalliata*, but they are not connected with the siphonal septum or the sphincter of the incurrent siphon and, with few exceptions, the columnar fibers simply connect the inner and outer laminæ of the lobe of the mantle in which they are respectively situated. Over the surface of the muscular mass near the median line behind the commissure of the mantle edge is distributed a quantity of glandular tissue which reaches up to and partly around the lower portion of the sphincter of the branchial siphon between the laminæ of the mantle lobe. The aggregation of glandular cells is so arranged as to leave channels which lead toward the vicinity of the sphincter, where they probably open to the surface, though I was not able to detect the orifices. The internal face of the incurrent siphon is concentrically wrinkled by the contracted sphincter, which below seems to merge with the pallial marginal band and above is overshadowed by a broad, smooth siphonal septum. The orifice itself, as retracted, from an internal point of view, presented a vertical smooth-edged slit, of which the margin projected internally to a marked degree. Externally the perisiphonal area is papillose, the papillæ not seemingly arranged in regular ranks, but the outer ones larger and the size diminishing focally toward each orifice. One papilla, larger than any of the rest, is situated in the median line above the excurrent orifice, but there is no medial papilla ventrally. The excurrent siphon, as usual, is

smaller than the other, and its valve or orifice in the alcoholic specimen does not project internally; both are surrounded with about the same relative amount of papillæ, which seem to be of about the same series of sizes for each orifice. The intestinal canal passes over the posterior adductor and terminates near the excurrent siphon, internally, but has no projecting free portion.

The outer lamina of the mantle when removed from the shell shows a band of short fibers less than 2 mm. in length and diminishing downward; they extend anteriorly from the mantle margin, and are disposed over the space in front of the siphonal area from the adductor above downward as far as the area extends. These are, without doubt, the retractor muscles of the siphons, and correspond to the slight concave curve below the adductor scar, which may be traced in the pallial impression. The mantle is remarkable for its large blood sinuses, and the pericardium is unusually large, as well as the ventricle of the heart. The latter is a thin, semitranslucent pear-shaped sac, dorsal to the rectum and not pierced by it. It is slightly asymmetrical, lying a little more to the right on the median line. The auricles enter the base laterally, being set off by a marked constriction, and are muscular and of a darker color than the ventricle, apparently having a thin glandular coating. Laterally from each auricle a funicular muscular tube extends to a capacious sinus in the wall of the mantle. There is a single anterior aorta starting from the base of the ventricle. The pericardium and its contents lie behind the cardinal teeth and beaks. The visceral mass below the latter seems but moderately supplied with hepatic lobules, and, superficially, exhibits the ramifications of the ovary. The male glands are lower down and of a pale color. The foot resembles that of *Verticordia* in being somewhat constricted above, but is much more like that of the average pelecypod. It is pointed and produced moderately in front, compressed, the lower part somewhat keeled, the posterior more swollen, with a slight "heel," and no trace of a byssal groove or gland. The retractor muscles of the foot form a slender, solid cord below, which ascends and bifurcates behind the middle of the shell and is attached on each side above the main body of the adductor, but forms an almost indistinguishable part of the same impression on the shell. The protractors, however, make separate scars a little behind and above the anterior adductor scar.

Reversing the animal and separating the lobes of the mantle, we find the foot closely embraced above by the ctenidia, which extend forward and are attached firmly to the mantle at their outer edges, and anteriorly reach to a point close to and just outside of the ventral pair of palpi. In looking down upon the reversed animal the most anterior part of the ctenidia is concealed by the foot and palpi. Leaving a fuller description of the gill until later, attention may be directed to the parts about the mouth. Just behind the anterior adductor are perceptible two or more pouch-like sacs on each side in front of the

dorsal palpus, which is more or less attached to this blister-like body. On cutting the tissues so as to expose the parts it is seen that the sacs form part of the dorsal palpi which are largely adnate upon the posterior faces of the sacs, with the free extremity recurved and coiled as in the figure.* The sacs when opened appear empty and thin walled, resembling blood sinuses. The palpi are not distinctly cross striated, but are more or less folded, like a book, upon themselves. The ventral palpi are long, slender, and nearly smooth. Between the bases of these projects a sort of lappet of cuticular tissue, broad, flattish, bifurcate behind and lying against, but not attached to, the anterior edge of the upper part of the foot. Above it the mouth is visible as a narrow slightly arcuate slit. I have not observed before anything exactly corresponding to this lappet in any pelecypod I have examined or found mentioned in the literature. What the office of the sacs in connection with the palpi may be I can not imagine, unless, when filled with fluid, their contraction may erect the tissue of the palps.

The most interesting part of this investigation relates to the ctenidia. These resemble in construction the archaic gills of *Yoldia*, *Solemya*, etc., with interesting differences. Behind they are firmly attached to and continuous with the broad siphonal septum; on each side and in front their outer edges are firmly soldered to the mantle. The inner edges on each side of the foot are confluent near the base of insertion and bordered by a smooth band of connective tissue which is closely appressed to, but not organically connected with the foot, which passes between them. These edges behind the foot, however, are united to each other by delicate yet firm tissue not easily ruptured. Looking down upon this surface, beside the median line of junction it is seen to be marked by two impressed grooves on each side between which, obliquely waved, extend the edges of closely appressed plate-like lamellæ. On cutting the gills transversely it is found that these plates present much the appearance of the same organs in *Yoldia limatula* as figured by Mitsukuri,† but with important differences. The fibrous suspensory tissue, by which the ctenidia are connected with the mantle, forms a narrow band extending obliquely at an angle of 35° to 45° from the vertical plane of the body, when it is perforated by a large vessel running longitudinally. Morphologically below this, but actually obliquely outward, is a band of smooth tissue separating two sets of lamellæ. These lamellæ are not equal and symmetrical as in *Nucula*, nor are they set at right angles to the stem of the gill, but trend obliquely backward on each side like the vanes of a feather. The outer set of lamellæ are wider from side to side and shorter vertically than the inner set. The latter are separated by a narrow membranous band from a third set, forming an ascending or reflected lamina, for which I was unable to detect any main blood vessel comparable to that of the main stem of the gill. The upper surface of

* Compare pl. XXIV, fig. 5, p.

† Studies from Biol. Lab., Johns Hopkins Univ., II, pl. XIX, fig. 11, 1882.

the gill is furnished with numerous longitudinal muscular fibers, at about equal distances apart, which firmly connect the upper edges of the lamellæ. The border of the inner lamina where it lies against the foot is defended, as above stated, by a thin band of smooth tissue, and where the plates join this band their edges are confluent. The same is true of the edges of the outer set where they impinge upon the mantle. The connection is very brief and just at the appressed edge of the gill. Each plate appears to form a single blood sinus or sac, as in *Nucula*, with numerous radiating muscular fibers, as figured by Mitsukuri in *Yoldia* (Tab. cit., fig. 11). The main surface is composed of conspicuously cellular epithelium, as in *Nucula;* the edges are abundantly ciliated. The plates

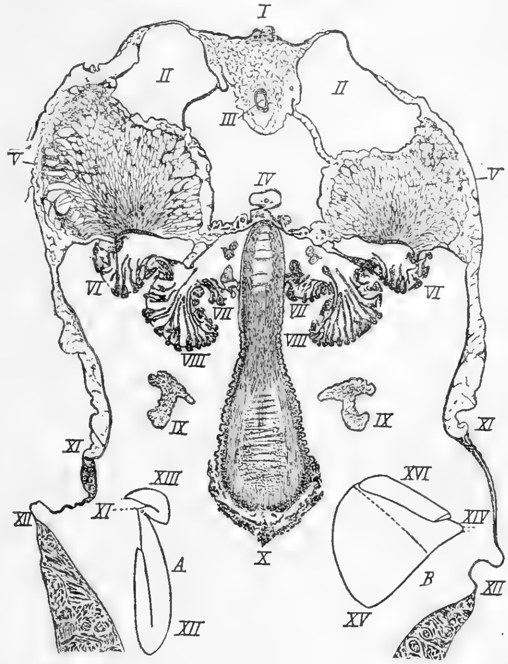

Fig. 1.

MICROTOMIC SECTIONS OF EUCIROA PACIFICA AND CALLOCARDIA STEARNSII *

*Figure 1. Microtomic section of *Euciroa pacifica*, Dall, taken through the middle of the foot, the lower part of the mantle lobes being omitted. From camera lucida drawing from the original by J. C. McConnell, $\frac{6}{1}$.

I. Dorsal commissure of the mantle; II, II, blood sinuses connected with the auricles of the heart; III, the rectum; IV, cavity of the nephridia; V, V, reticulated connective tissue; VI, VI, direct outer limbs of the ctenidia; VII, VII, inner reflected laminæ, and VIII, VIII, inner direct laminæ of the inner limb cut in a slightly oblique section across the single plates; IX, IX, the palpi; X, the foot, more or less surrounded by loose epithelial matter; XI, XI, lobes of the mantle; XII, XII, beginning of the muscular region of the mantle lobes; incomplete below.

Figure 1, A. Section of left ctenidium of *Callocardia stearnsii*, Dall, $\frac{4}{1}$.

A. XI, *Callocardia*, stem of the gill with blood vessel; XII, inner direct and reflected limb; XIII, outer direct and reflected limb in section.

Figure 1, B. Side view of left ctenidium of *Callocardia stearnsii*, showing outline of the inner and outer limbs; the dotted line showing the limit to which the inner reflected lamina of the inner limb rises on the side opposite that of the observer.

B. XIV, point where the ctenidium is attached to the siphonal septum; XV, ventral extreme of the inner direct limb; XVI, outline of the outer direct and reflected limb; the inner reflected laminæ on the side next the body rises to the height indicated by the dotted line. The single plates of which the gill-mass is composed are not indicated.

are distinctly marginated, as in *Nucula*, but are connected together by small patches of what appeared to be fibrous tissue, which proves to be interlocked giant cilia (see fig. 2, VI). Owing to the oblique manner in which the plates are set on the stem, and the manner in which they are tied together, it is difficult to get a section which will show the whole face of any single lamella and determine exactly how many ciliary bridges exist to each plate, but the distal margins of the plates were free from each other for some little distance inward. The outer edges of the lamellæ appeared to be furnished with a small circular band of muscular fibers by which the periphery might be contracted, but no rigid chitinous framework could be detected. Along the channels between the series of plates were accumulations of dark-colored organic granules, indicating that the ctenidia perform the function of collecting food material.

After using a low-power lens in dissecting in the ordinary way, serial sections with the microtome, after hardening and staining, were resorted to, in order to get at the structure of these and other organs. Dr. Gray, microscopist of the Army Medical Museum, kindly undertook the manipulation and mounting. It was found that the processes required, as preliminary to sectionizing, were destructive of many delicate features which with the dissecting microscope are easily observed in fresh material. On the other hand, the sections (shriveled and distorted as they are, compared with fresh specimens) exhibited a number of

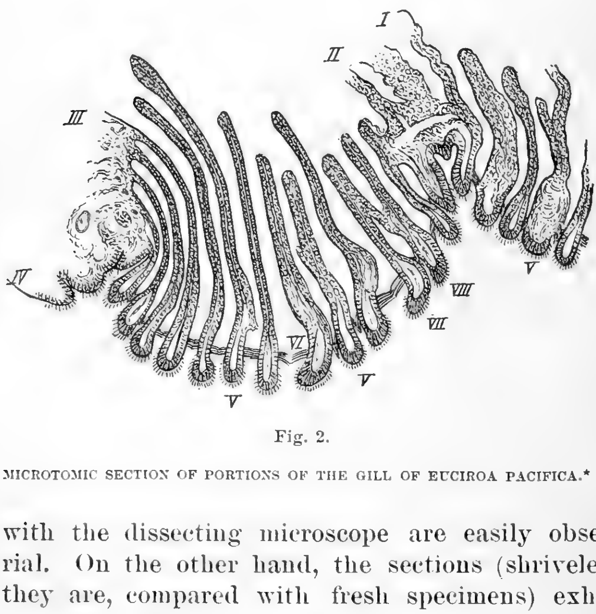

Fig. 2.

MICROTOMIC SECTION OF PORTIONS OF THE GILL OF EUCIROA PACIFICA.*

*Figure 2; section of the plates of the inner reflected lamina of the gill of *Euciroa pacifica*, greatly enlarged, from microtomic section at a tangent to the anterior surface of the posterior adductor, camera lucida drawing by J. C. McConnell.

I, II, combined plates at the point of reflection, defective above; III, IV, mass of connective tissue, etc., forming the junction of the right and left ctenidia behind the foot; V, V, V, plates which have been torn by the knife in cutting, simulating vascular connections; VI, giant cilia connecting the plates distally; VII, VIII, plates connected by a true vascular junction.

For a proper conception of the real relation of the parts before shriveling by the staining process, the reader should refer to pl. XXIII, fig. 2.

points of structure which were not observable otherwise. It is evident that both methods are required for complete results. In the present instance, in examining the gills in water with low powers, it was observed that the close set oblique plates, or lamellæ, are connected at their dorsal edges by a delicate series of connective fibers running in an antero posterior direction and recalling the threads which connect the dorsal edges of the laminæ in *Poromya*, but more numerous, and laterally, near the attachment to the mantle, forming a sort of *fascia*, or layer of fibres. Beside this, the dorsal portion of the plates near the arterial stem of the gill show a few reticulations carrying blood vessels, and a good many which appeared purely fibrous. The vascular connectives, except close to the stem as above mentioned, were not observed, though here and there a fibrous link united the faces of two plates near their dorsal margins, but without any regularity of situation or succession. The arterial stem, which anteriorly has a roughly triangular section, near the posterior ends of the gills is produced vertically, so that the short laterally extended plates of this part of the gill, instead of hanging below the stem, are projected from its opposite sides, and are not all of the same vertical width. This appeared very clearly in the microtomic sections, in which, however, no trace of the longitudinal dorsal fibers could be recognized, the latter having been apparently destroyed by the contraction induced by chemical treatment used in staining, with many other more delicate features. The sections therefore show the lamellæ as more isolated than they are in reality, except near their ventral edges, where they are bordered by a narrow band of giant cilia, which interlock between the plates, thus holding the ventral margins quite firmly together. These junctions were well shown in the sections, and also, though less clearly, the distal margins of the plates showed patches of smaller cilia, not continuous with the band above, but projecting into the peripedal cavity, and doubtless serving, as in other pelecypods, the purpose of collecting and propelling grains of edible matter toward the mouth.

The nephridia lie below the pericardium and are distinctly limited by the connective tissue made up of a radial network of fibers which constitutes the lamina to which the outer edges of the gills are attached. The nephridia have a common cavity (fig. 1, iv) more or less occupied by thin folds of very delicate tissue of a more or less glandular nature, upon and around which are clustered large numbers of spherical nucleated or concentric concretions similar to those already described in *Lyonsiella* and other Anatinacea. These concretions stain deeply and are very varied in size, the largest exceeding any of those noticed in *Halicardia*. The nephridia do not extend laterally into the lobes of the mantle as they do in *Halicardia*.

The character of the gills above described is such that it seems not unreasonable to regard them as intermediate between the foliobranchiate gills of such a mollusk as *Solemya* and the plicated reticulate gills of a more modern type of bivalves, such as *Lyonsiella* or *Halicardia*. They

are neither typically foliobranchiate nor normally reticulate. Hitherto those who would separate the filibranchs ordinally from the modern reticulate forms have been obliged to institute an intermediate order, "pseudo lamellibranchs," to receive those pelecypods with a "filibranchiate" organization which persist in developing reticulate gills. The evidence of the ancestry of the filibranchiate types afforded by paleontology is sufficiently weighty to show how artificial is any such arrangement, and how little in accord with the phylogeny of the forms concerned. But while the transition between the filibranchiate and reticulate gills has always been sufficiently obvious, there has been a very marked gap between the foliobranchs and any of the others. This the present type does something to bridge, or, at least, to indicate how it might be and probably was bridged in the past. It adds something also to the testimony for archaicism in the Anomalodesmacea which the present writer, in conformity with paleontological evidence, has pointed out.

After the above was written the writer was unexpectedly enabled to examine the gill in two species of *Callocardia*, dredged in the Pacific Ocean by the *Albatross* off the coast of Central America, in about 400 fathoms. Contrary to the known *Cardium*-like type of reticulate gill which characterizes the shallow water *Isocardia* (with which *Callocardia* has hitherto been associated as a subgenus), the ctenidium proves to be even nearer to the typical foliobranch gill (such as that of *Solemya*) than is the gill of *Euciroa*. The single ctenidium in *Callocardia stearnsii*, Dall, is composed of the central stem and two sets of ribbon-like lamellæ, which spring from either side. These lamellæ are thick and fleshy (relatively to their size), and are attached to each other at their proximal ends by the common adhesion to the stem, and at their distal ends by a narrow fibrous strip, which may possibly contain a vascular channel, but did not show any in the present condition of the specimens. There are indications of a lateral band of cilia; at all events, the edges of the lamellæ are distinctly marginate and yet not organically connected. The inner limb of the ctenidium is much the larger, rounded triangular in outline and with a bluntly rounded keel below, the distal portion of the mass of lamellæ being reflected and closely appressed to the direct limb, and reaching upward about two-thirds of the way from the point of reflection to the arterial stem. The outer limb is very much smaller than the inner one, but has the reflected part longer and larger than the direct, so that the dorsal edge of the reflected portion extends toward the middle line of the body over the stem, covering the dorsal edge of the direct part. (See figure 1, A, B.)

The shell of *Callocardia* closes so tightly that the preservative used had penetrated slowly and the specimens are not in a condition to use for sections. It can be positively stated, however, that there are neither fibrous nor vascular connectives between the lamellæ, except as above mentioned, and the chief difference between the ctenidium of *Callocardia* and that of *Solemya* is obviously that the lamellæ are united by

a narrow band distally and reflected in the former, while they are comparatively free and not reflected in the latter. It may be added that the entire ctenidium is solid and fleshy as in *Nucula*, and when lifted separates from the body in a single mass. The two ctenidia are united to the siphonal septum behind the foot, but not to each other, so there is no complete anal chamber. The palps in *Callocardia* are very small, the foot is flattened and solelike below anteriorly and rounded behind. The siphons are complete and papillose, longer than in *Isocardia*, but still short.

The discovery of this type may be said to practically complete the series uniting the foliobranch with the reticulate gill and give the quietus to the classification based solely on the divergencies of the ctenidia.

It can hardly be doubted that the gills of *Euciroa* are represented by the degenerate small gill of *Verticordia acuticostata*, as formerly described by me. It seems possible, as will appear under the next species, that the fleshy septum of the so-called Septibranchia may be partly a modification of such an inwardly-directed lamina of the mantle as in *Euciroa* lies below the visceral mass; and in *Halicardia* has free edges; which in *Euciroa* is merely connective, but in *Halicardia* contains an extension of the nephridia. What part in *Verticordia* the siphonal septum plays remains to be decided by further researches, but it also contributes more or less extensively to the total septum. Geologically the *Verticordiidæ* are an ancient group, and the fossil *Pecchiolia* would seem to be very nearly related to *Euciroa*. At all events the latter, in its dorsal heart not pierced by the rectum, its single aorta, and archaic type of gills, adds a very interesting member to the small list of pelecypods of varying affinity, which retain in their organization indisputable traces of archaic origin.

In this connection I was led to examine the following species, also dredged by the *Albatross*, but on the northeastern coast of the United States, a specimen of which recently came into my possession. Owing to its large size the characters of this mollusk are very plain and unmistakable. Hoping to obtain some light on the vexed question of the origin of the fleshy septum of *Verticordia*, I examined it with a good deal of interest, and found, as will be seen, a type of septum which seems wholly distinct from either of those hitherto described. The species referred by its describer to *Mytilimeria* and by the writer to *Verticordia* s. s., must evidently form the type of a new genus.

Genus HALICARDIA, Dall.

HALICARDIA FLEXUOSA, Verrill and Smith.

Plate XXIII, figs. 1, 3, 5, 6; plate XXIV, fig. 3.

Mytilimeria flexuosa, VERRILL and SMITH, Trans. Conn. Acad., V., 567, pl. 58, fig. 38; Am. Journ. Sci., XXII, 1881, p. 302; Trans. Conn. Acad., VI, 1884, p. 258.
Verticordia flexuosa, DALL, Blake Pelecypoda, Bull. Mus. Comp. Zool., XII, p. 286, Sept., 1886.

The specimen was dredged east of Georges Bank, in the Gulf of Maine, in 677 fathoms, brown sand; bottom temperature, 39° F., by the

U. S. Fish Commission in 1885. The shell measured 45 mm. wide and high by 39 mm. long. No. 50785, U.S.N.M.

The shell is wide and angular, resembling a large *Hemicardium*, with a granular ashy-white or pale-brown granulose surface, showing faint traces of radiating ridges. The hinge is obsolete, an obscure swelling represents the sublunular tooth in the right valve and a still feebler one in the left valve. In *Euciroa* the left portion of the lunule is the most prominent; in *Halicardia* the opposite is the case. The lithodesma is an asymmetrical slender, solid, shelly arch, with the right limb decidedly longer than the left one. The inner margin of the shell is smooth, the valves are a very trifle unequal and shut closely.

To facilitate comparison the characters of the soft parts are given in the same order as under *Euciroa*.

The mantle, in its thickness and consistency, resembles that of *Euciroa*. Its margin is thick and solid, and the inner ridge more distinctly papillose than in *Euciroa*, but not conspicuously so. The lobes of the mantle are first separated in front of the middle of the anterior adductor and continue so, backward, about halfway to the siphon, thus leaving a shorter pedal opening than in *Euciroa*. The thickened mantle-edge frames the perisiphonal area, and its two sides are united above and a little in front of the posterior adductor. In the lobes of the mantle behind the siphon there is nothing corresponding to the muscular areas of *Euciroa*. The siphons recall those of *Poromya*. The excurrent siphon is small, short, surrounded by insignificant granular papillæ irregularly distributed sparsely over the perisiphonal surface; a single larger but still very small papilla is visible in the median line above the siphon, and distant half the diameter of the orifice. The edges of the siphon are thin and entire; between it and the incurrent siphon the surface of the perisiphonal area is finely granular and somewhat impressed. The branchial siphon is enormous, its longest diameter externally about one-sixth the total circumference of the mantle. It is surrounded by a single row of long, strong tentacular processes, flattened on their inner faces, rounded and inflated outwardly, and covered with a distinctly granular epithelium. There are fourteen on each side, and one in the median line above, not differing from the rest. Externally these tentacles (as contracted in alcohol) are as long as one-fifth the greatest diameter of the whole siphon, and are of nearly equal size and length. They are surrounded by a cingulum rising from the perisiphonal area elevated and constricted; from within, the wall of the siphon is seen to be formed by parallel cylindical prominences which continue the tentacula forward to the base of the siphonal tube. The siphonal valve is circular, broad, and with a thin edge finely crenulated. The valve occupies the base of the siphon like a perforated diaphragm, and does not project inward. Above it the siphonal septum is narrow, smooth, and a little produced forward in the median line. There is no special set of muscular fibers inserted upon the valve

for the retraction of the siphons; this is doubtless performed by the contractility of the thick and wide muscular mantle edge. The mantle, owing to its thickness, affords abundant space for blood sinuses, but they are less marked than in *Euciroa*. The pericardium, proportionally, is much smaller than in *Euciroa*, and the ventricle of the heart is reduced to a small, rounded-triangular body, which is perforated by the rectum, gives off an anterior aorta and two unequal lateral auricles, either of which is as large or larger than the heart itself, and the right auricle distinctly larger than the other. The position of the pericardium with respect to the hinge is about the same in both genera. Below and around it, occupying a very large part of the upper portion of the visceral mass, is the ovary, easily discriminated from adjacent structures by its deep purple color. This is due, not to the ovary itself, apparently, but to the presence of the nephridium more or less closely interramified with it. A section of the latter just behind the pericardium shows that it occupies, not only nearly the whole space between the dome of the mantle and the roof of the anal chamber, but extends on each side downward, occupying the lateral walls as well as the roof, and is then produced inward from the mantle as a thick, longitudinally plicate, and variously recurved lamina, forming equally part of the floor of the anal chamber (into which its free edges project) and of the roof of the peri-pedal or branchial chamber. It thus contributes to form about half the septum between the two chambers, and, unless the fleshy septum of the typical *Verticordia* proves on reexamination to be of this character, we have here an example of an unexpected and wholly new element contributing to the building up of that part of the organization. Investigation shows that an analogous but less conspicuous instance may be found in some species of *Lyonsiella*.

Internally the nephridium is irregularly cavernous in its thicker parts, traversed by multitudinous columnar fibers covered with a glandular endothelium. Where the walls of the organ are close together as they are laterally, and in the recurved lamina, the fibers run almost directly from one wall to the other. In the thicker portion they pass radially in every direction. The substance of the ovarian gland is whitish, and from its surface project in various stages of protrusion and pedunculation the growing ova, which are externally smooth and opaque, but in the free ripe ova are covered with a thin, perfectly transparent layer. The nephridia, or organs of Bojanus, carpet much of the peripheral and part of the internal surface with a rich deep purple glandular tissue, giving rise to multitudes of circular, somewhat compressed, calcareous granules, which, by transmitted light, appear of a rich amber color with a strongly marked nucleus. The ova are discharged in large numbers into the anal chamber, where they lie immersed in a transparent glairy mucus, which does not seem to be affected by water. I was unable to find any eggs which showed signs of segmentation. The walls of the laminar portion of the nephridia are double, externally smooth,

and show the marbled whitish and purple coloration of the interior. The purple matter tinges fresh water of a yellowish amber color.

The anterior portion of the foot resembles that of *Euciroa*, and it shows a small byssal groove, from which an extremely slender byssal thread or two proceeds, and was observed by Verrill. But behind the byssal groove, on the median line of the visceral mass, is produced a thin, compressed, fin-like body, which I propose to name the opisthopodium, and which in life may be nearly flat vertically, but in alcohol is so contracted as to cockle the distal margin, giving the organ a peculiar aspect, entirely unlike that of any pelecypod foot I have ever examined, and strikingly like a fin. Something analogous was described by Owen in *Pholadomya*. The retractors of the foot are double on each side for more than half their length. The attachment is behind and somewhat separated from the anterior adductor in the case of the protractors, while the retractor scar touches the upper angle of the posterior adductor.

On separating the mantle lobes and examining the roof of the peripedal cavity we observe a large visceral cone of oblong section, at the anterior lower extremity of which is the functional foot, while behind the latter is the fin-like expansion I have already referred to. Closely embracing the base of the pedo-visceral cone, and extending forward to the mantle at the sides of the mouth, partly covered by the free edges of the palpi, and backward to the siphonal septum, are the ctenidia. These are the morphological equivalents of a single gill stem on each side, with lateral expansions; on the one hand closely appressed to the side of the foot, on the other to the lower face of the longitudinally plicate inwardly extended nephridial lamina. The stem containing the main venous trunk is not perceptible from below, except under magnification, when a parting between the surface crenulations of each lateral portion is visible, but very inconspicuous. The whole of the gill except the stem is of extreme thinness, like a canopy of lace, and the portions on each side of the stem are full and irregularly pendulous. There is no vertical gill lamina, but the canopy, between its attached edges, bulges downward in an irregular longitudinal prominence, as if not drawn sufficiently taut. By careful scrutiny on the prominence corresponding to the inner lamina a very slender longitudinal raphe may be detected, probably corresponding to the morphologically lower edge of the inner reflected lamina of the gill in normal ctenidia. On the outer prominence corresponding to the outer lamina there is no raphe. The lower or respiratory surface of the gill resembles in miniature that of the so-called Turkish bath towel, the transverse lamellæ being disposed in rather regular zigzag, extremely minute, elevated bands, frequently interrupted, but often continuous across the whole lamina. The edge next the foot is defended by a narrow membranous margin, which is firmly attached to the median line of the foot behind, but only closely appressed elsewhere. The stem of each gill curves round behind the foot about midway of the ctenidial surface, and the two are joined in

the median line, recurving to the point of attachment to the foot, thus showing that the gill, if normal, would not be attached (as in so many cases it is) to the siphonal septum, but to the foot. The structure of the gill comprises large lateral branches, given out from the sides of the stem at intervals (which grow smaller posteriorly); below these are close-set smaller longitudinal tubes extending from one end to the other, below which again is a reticulate surface of cellular epithelium, from which are given out the very narrow, zigzag, transverse lamellæ already referred to, hardly projecting from the epithelial carpet. The portions corresponding to the outer lamina of each gill are more bellied downward than the inner lamina, but both are otherwise alike in tenuity and structure, except for the presence of the raphe on the inner one.

The oral palpi are thin, muscular, and smooth, except for wrinkles radially directed toward the periphery from the mouth, but the surface is not regularly striated. The palps are continuous in the median line above and below and adnate to the surface of the mantle except at the extreme edge above and partially to the front edge of the visceral mass below. The absence of the regular channels on the gills and of striations on the palps leads to the inference that the ciliary action of the gill surface plays a smaller part in the collection of food in this form than in ordinary pelecypods. There is nothing corresponding to the peculiar bifid lappet noted in *Euciroa*.

Serial stained sections of a part of this specimen, including the outer limb and stem of the left ctenidium, the free, infolded lamina, and part of the mantle lobe above and below the point from which the lamina is given off inwardly, show that, in staining, the connective and glandular tissue of the mantle and nephridium contract out of all proportion to the denser tissues of the gill, foot, muscles, etc. The delicate columnar fibers transverse to the lumen of the nephridium are almost wholly lost, ruptured, or distorted out of recognition. By way of compensation, however, the sections showed conclusively that the free lamina, though connected with the outer edge of the gill, is absolutely distinct from it organically, and is continuous with and an undivided part of the tissues of the mantle lobe from which it springs. The ramification of the nephridium, which extends between the walls of the mantle and out into the lamina, does not extend ventrally between the mantle walls below the point where the lamina arises. The space below this point, between the walls of the mantle, is filled with connective tissue. The nephridial concretions, which are abundant in the recesses of the gland, are apparently of two sorts. One, which was noticed before the sections were made, is translucent, pale, or brownish and stains feebly. The other sort in the fresh animal has a more purple color, is more deeply embedded in the glandular epithelium, and, in the sections, stains black. The presence of free ova in the cavities of the nephridium I am unable to account for, but is unde-

niable. None of them seems to have undergone segmentation. The orifices of the genital glands are situated on the surface of the visceral mass, close to but not coalescent with each other, a pair on each side symmetrically above the opisthopodium. A large number of ova existed in the suprabranchial chamber, embedded in a large mass of transparent jelly, the office of which may be surmised to be their retention in the chamber during the ejection of water from the anal siphon. The ovary is distributed rather superficially anterior to and outside of the nephridial mass. The ova are spherical, covered with a transparent layer of epithelium distinctly pedunculated at the point where it separates from the ovary, but which is soon lost. The eggs are relatively large and perfectly visible to the naked eye. In the specimen the contents had been hardened and whitened by the alcohol, but showed no indications of segmentation. The jelly-like mass in which they were embedded after leaving the ovary was very posterior, gathered in and over the folds of the mantle lamina, chiefly on each side of the opening of the anal siphon, and not at all over the dorsal surface of the gills. Some of the jelly was taken out and put in a receptacle full of water, where strong currents of water directed upon it with a small syringe failed to dislodge the ova. This explains how, in species which incubate the eggs in the anal chamber, they may be retained there when the water in the chamber is expelled, a matter which otherwise would be something of a puzzle.

The differences between this genus and *Euciroa* and *Verticordia* are sufficiently conspicuous. No doubt the relation is more close with *Lyonsiella*. If the thick fleshy imperforate septum of *Verticordia* is in any way homologous with the reflected nephridial lamina of *Halicardia*, the relationship might be regarded as quite close. But the impression derived from the dissection of *Verticordia acuticostata* was that the septum there is an extension of the siphonal septum. I have endeavored without success hitherto to obtain another specimen of *Verticordia acuticostata* for the purpose of making microtomic sections which would probably settle the question. The most important result of these comparisons at present is the light it throws on the mutability of the breathing organs within relatively narrow systematic limits. No one who has studied many of the recent and fossil *Verticordiidæ* can doubt that the three genera above mentioned are related, and descended from the same ancestral stock. Yet we find in one an archaic lamellar gill, in the second, a fleshy septum and a degenerate adnate gill, and in the third a gill which, morphologically, is homologous with the gill of *Anatinacea*, but here is specialized in a way to which no parallel is yet known, and with a septum partly made up of a reflected nephridial lamina. Is the result of the presentation of these facts to be the creation of three alleged "orders," or the recognition of the mutability of an organ which never should have been used as a sole basis for the higher systematic divisions? I believe the latter to

be the true answer, whatever the morphological equivalents of the septum may prove to be in any given case. The proposed order "*Septibranchia*" seems to me founded merely on extreme specialization of organs which may be expected to vary almost infinitely and of which the intermediate and connecting stages will probably be found fully exemplified in the various genera of *Anatinacea* when exhaustively investigated. Toward that desirable state of our knowledge the preceding notes will contribute data of importance.

Genus LYONSIELLA, Sars.

LYONSIELLA ALASKANA, new species.

Plate xxv, fig. 2.

Shell thin, large for the genus, inequilateral, the anterior end shorter and more vertical, the posterior end more rounded; covered with a pale, yellow, silky epidermis considerably infolded around the margins of the valves; sculpture of fine, distant, radiating, elevated threads about half a millimeter apart near the margin; the interspaces crossed by silky lines of growth which are occasionally emphasized as if at resting stages of growth; interior faintly pearly; hinge line edentulous, with a large lithodesma shaped like a flattened shell of *Vaginella*, with a deep sinus in the wider (posterior) end; beaks moderately prominent, much incurved; lunule larger on the right valve, small, heart-shaped, polished; a narrow polished strip on the posterior dorsal edge of the valves may represent an escutcheon. Length of shell, 24; height, 24; diameter, 16 mm.

Station 2859, in 1,569 fathoms green ooze, southwest from Sitka in the Gulf of Alaska; bottom temperature, 34.9° F. No. 123500, U.S.N.M.

This species closely resembles externally *L. radiata*, Dall,* from the Straits of Magellan, but is larger, with the anterior end more vertically truncate, the posterior end and base more evenly rounded, and the beaks more central and inflated.

For the purpose of comparison with *Halicardia* the soft parts of this species were examined. In a general way the arrangement of the parts is not unlike that in *L. papyracea*, Smith, as figured in the *Challenger* report (Anatomy of mollusks, pl. II, fig. 8). The anal siphon is short and smooth edged, with a somewhat granular exterior; the branchial siphon is surrounded by a single row of large tentacular papillæ, each tentacle being subtriangular, with a projecting barb-like point at each side near the base of insertion, the whole surface distinctly villous and slightly compressed in the same plane as the valves; there are ten of these papillæ on each side, diminishing in size anteriorly, with a small one in the median line in front; these and the anal siphon are surrounded by an area of nearly bare membrane (which I call the perisiphonal area) extending to the mantle margin; behind the anal siphon

* Proc. U. S. Nat. Mus., XII, p. 276, pl. VIII, fig. 7, 1889.

on this area are three large conical papillæ, the largest and uppermost standing in the median line. The outer mantle margin is thin and smooth edged, covered in the natural state by a wide infold of the epidermis. The secreting margin of the mantle is thickened with a single row of conical short papillæ just within the edge; behind about every fifth, and in front about every eighth papilla is distinctly larger than the average, and a little more set back from the edge. The pedal opening is short and anterior. The foot, as in the *L. papyracea*, is relatively large, glandiform, and byssiferous. The inner opening of the branchial siphon is furnished with a circular smooth membranous valve. The mouth is very large and funicular, the opening radiately striate; the anterior palpi are indistinguishably merged with the membrane above them, and their outlines can not be traced; the posterior pair are adnate, short, wide, and apron-like, not separated by a median sinus below. From under them start the gills, which are attached by their outer margins to an infolded nephridial lamina, as in *Halicardia*; their inner margins are bordered by a rather wide smooth membrane, with crenulated edge, which appears to be attached in each case to that of the opposite gill behind the foot, but the attachment is so delicate as to rupture at the slightest strain, so that it leaves a doubt as to whether the junction all along the line is complete or not. Above the opposite border is a narrow recurved free membrane corresponding to the ascending limb of an ordinary gill, but which has no lamellæ, and is perfectly smooth. The main arterial stem of each gill extends to the siphonal septum to which both are anchored, not, as in *Halicardia*, being recurved to join each other midway between the keel of the foot and the siphonal septum. The inner edges of the gills at their commissure behind the foot are united firmly to the foot as in *Halicardia*. The heart is small, with insignificant auricles, and the ventricle is pierced by the rectum, which is large. The ovary, as in *Halicardia*, is enormous, of a yellowish color, crammed with ova, which are discharged in a glairy mucus which accumulates in the anal chamber. The structure of the gills recalls that of *Halicardia*, but they are thicker, with fewer and more projecting lamellæ, more or less zigzag in their course. Above it is seen that the longitudinal elements of the reticulum predominate over the transverse branches, the contrary being the case in *Halicardia*. The infolded lamina of the mantle in this species is longitudinally folded, and has a free edge, and subcylindric posterior free end almost exactly as in *Halicardia*. All parts of it are irregularly cavernous and filled with lobes of the ovarian gland bearing ova in all stages, which appear to be discharged into the anal chamber by a passage opening near the median line on each side of the visceral mass behind close to the nephridial orifice.

In Pelseneer's account of the various species of *Lyonsiella*, described in the *Challenger* report, no such free lamina of the mantle is described, and the gills are represented distinctly, both in text and figures, as

attached to the mantle in the ordinary way. It is hardly credible that he could have overlooked so prominent a feature, but there is nothing resembling it described by him. He figures an oval glandular spot on the mantle, of which he says, "There is on the mantle a glandular swelling comparable in its position to the hypobranchial gland of gastropods." But this statement in no way expresses the condition or relation of the parts in the present species, or in *Halicardia*, and hence we must suppose, if reliance is to be placed on Pelseneer's account, that the species he examined differs from *L. alaskana* and *Halicardia* in wanting the free lamina to which in these species the outer edges of the gills are attached, and in having the gills attached directly to the mantle.

The lithodesma of the very young *Halicardia* is shown by a specimen in the National Museum to be shaped like that of *L. alaskana* and *L. papyracea*, but in the adult *Halicardia* it has assumed a totally different form. The character of the branchial siphon, pedal opening, lithodesma, and details of the shell are sufficient to separate *Halicardia* from the *Lyonsiella* of the type of *L. alaskana* and, if we accept Pelseneer's account, the latter can not be united with *L. abyssicola*, Sars, which is the type of the genus *Lyonsiella*, but must be separated to form a separate group, which might be placed as a subgenus under *Halicardia*. But I must confess to doubts as to Pelseneer's accuracy, in this particular,* sufficiently strong to make me feel it inadvisable (until his account is confirmed by new evidence) to name and separate the species allied to *L. alaskana*. In case they prove to agree with *L. abyssicola*, *Halicardia* will have to take its place as a subgenus under *Lyonsiella* as the older name.

Genus PECTUNCULUS, Lamarck.

PECTUNCULUS ARCODENTIENS, new species.

Plate XXVI, fig. 6.

Shell small, rather inflated, thin, high, and sculptured with about sixteen rounded, prominent ribs, with very narrow interspaces crossed by fine elevated threads; area small, wide, subtriangular; hinge line narrow, evenly arched with about eight teeth on each side of the beaks; basal margin narrow, indented by the sculpture, with obscure interlocking dentations on the inner face opposite the interspaces between the ribs; adductor scars distinct, on a slight raised area extending into the umbonal cavity. Height of shell, 21.5; breadth, 20; diameter, 13 mm.

Station 3472, in 295 fathoms. No. 107014, U.S.N.M.

Although the single valve obtained is dead and has lost its color, and the surface is somewhat eroded, yet its characters will not permit us to refer it to any described species. None of the coarsely ribbed species combine transverse reticulation with so thin and rounded a shell, and it is quite peculiar in the evenly-rounded arch of its hinge plate.

* Pelseneer has since admitted the incorrectness of his first account of the attachments of the gill in *Lyonsiella*. Compare Arch. de Biol. xi, 1891, p. 215, foot note 5.

The species nearest allied to this is probably *P. gealei* Angas, from Australia, but it has more numerous ribs and differs otherwise.

This concludes the series of Hawaiian mollusks, the following species being chiefly from the northwest coast, especially from the great plateau of Bering Sea, which is remarkable for having, at comparatively moderate depths, a fauna which seems entirely distinct from that of the shores, and yet is not an abyssal fauna, properly speaking. Members of this fauna, as will be observed in the notes on distribution, often reach a remarkable distance to the southward in water of the temperature normal to them, and, in fact, there are one or two species which may prove to extend from Bering Sea to Cape Horn when sufficiently full explorations are completed.

NORTHWEST AMERICAN SPECIES.

These were mostly described in the Proceedings of the United States National Museum, XIV, pp. 186–190, July, 1891, and are now figured with a few additional notes. Some errors in the details of habitat as given in the original are here corrected, and a few new species are added to the list.

Genus BUCCINUM, Linnæus.

BUCCINUM STRIGILLATUM, Dall.

Plate XXVII, fig. 9.

Buccinum strigillatum, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 186.

Station 3076, off Tahwit Head, State of Washington, in 178 fathoms; temperature at bottom, 43.4° F.; and south to station 3170, off Bodega Head, California, in 167 fathoms, muddy bottom. No. 122550, U.S.N.M. Other specimens were dredged off Guadelupe Island, Lower California.

BUCCINUM ALEUTICUM, new species.

Plate XXVII, fig. 7.

Station 3219, south of Unimak Island, Aleutians, in 59 fathoms, sand; bottom temperature, 38° F. No. 122591, U.S.N.M.

Shell thin, six whorled, covered by a thin sparsely pilose, dehiscent epidermis; of a livid pinkish color with a white pillar and margin to the outer lip and a dark chestnut nucleus; sculpture of extremely fine, regular, close-set grooves, with equal or wider interspaces, regularly spaced on the last, but tending to pair on the earlier whorls; spire short, rather pointed; whorls full; suture deep, but not channeled; aperture moderate; pillar with a white callous ridge incurved upon it; siphonal fasciole distinct, bounded by a groove behind; outer lip slightly thickened, hardly reflected; throat livid brown; operculum small, subcircular with a subcentral nucleus and fan-shaped scar of attachment. Length of shell, 35; maximum diameter, 21 mm.

The very fine, even striation recalls that of *B. tenue* Gray, but the form is more like *B. cyaneum*.

BUCCINUM OVULUM, new species.

Plate XXX, fig. 6.

Station 3491, near Amukhta Pass, Aleutians, in 248 fathoms, sand. No. 106997, U.S.N.M.

Shell small, thin, of about four and a half or five whorls; surface smooth, or with faint irregular spiral threads mostly obsolete; covered with a vernicose adherent olive-green epidermis; substance of the shell livid pinkish purple, with a white margin to the pillar and aperture; last whorl much the largest; suture deep but not channeled; nucleus eroded in all the specimens; pillar nearly straight, thin, with a deep, very short, hardly recurved canal; body sometimes with a thin wash of yellowish callus; operculum small, nearly circular, the nucleus subcentral, surface of attachment fanshaped, reflected by a depression in the concave outer surface. Length of shell, 25; maximum diameter, 20 mm.

This interesting and elegant species recalls *Voluthurpa*, but seems more nearly related to the preceding species.

Subgenus SULCOSINUS, Dall.

Shell thin, with a deeply channeled suture, strongly reflected lip, and thick parietal callous deposit. Type *Buccinum taphrium*, Dall.

BUCCINUM (SULCOSINUS) TAPHRIUM, Dall.

Plate XXIX, fig. 6.

Buccinum taphrium, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 186.

Station 3330, in Bering Sea north of Unalaska, in 351 fathoms, muddy bottom; temperature 37.8° F. No. 122548, U.S.N.M.

In the absence of the operculum and soft parts this remarkable shell can be only provisionally classified. It appears buccinoid, but differs from all true *Buccinum* by its channeled suture and prominent body callus. It may prove to be a wholly distinct genus, but for the present it seems best to refer it to *Buccinum* as a subgenus. Only a single specimen is known.

Genus CHRYSODOMUS, Swainson.

CHRYSODOMUS INSULARIS, new species.

Plate XXIX, fig. 3.

Station 3489, in Bering Sea near the Pribilof Islands, in 184 fathoms, muddy bottom; temperature 38.5° F. No. 107000, U.S.N.M.

Shell large, solid, rather thin, with about six whorls exclusive of the (decollate) nucleus; whorls full, rounded, slightly excavated in front of the appressed suture; sculpture of, on the last whorl, three sizes of flattish rounded threads, alternating regularly in size, but on the upper whorls of only two alternated sizes separated only by shallow grooves; transverse sculpture of moderately prominent incremental lines; aperture ample, the pillar lip blotched with livid pink

and white, the pillar twisted, with a solid white inner edge and strong siphonal fasciole; canal moderate, slightly recurved; outer lip slightly crenulated by the sculpture, sharp, very slightly expanded; throat smooth, pinkish; epidermis very thin and translucent, closely adherent to the surface; operculum normal, light brown. Length of shell (decollate), 100; of last whorl, 80; maximum diameter, 56 mm.

This fine shell belongs to the typical group like *C. fornicatus* and *C. liratus*, but by its compact, even, and uniformly constant sculpture and details of form, seems sufficiently distinct. No male specimens were obtained, but the characters observed in the soft parts were normal.

CHRYSODOMUS PERISCELIDUS, Dall.

Plate XXVII, fig. 6.

Chrysodomus periscelidus, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 187.

Station 2842, off the coast of Akutan Island, Aleutians, in the Pacific, in 72 fathoms pebbly bottom; temperature 41° F. No. 122643, U.S. N.M.

CHRYSODOMUS PHŒNICEUS, Dall.

Plate XXIX, fig. 1.

Chrysodomus phœniceus, DALL, *op. cit.*, p. 187, 1891.

Station 2862, off the British Columbian coast, in latitude 50° 49′ north, in 238 fathoms, sand; bottom temperature, 44.7° F. No. 122657, U.S.N.M.

CHRYSODOMUS ITHIUS, Dall.

Plate XXIX, fig. 4.

Chrysodomus ithius, DALL, *op. cit.*, p. 188, 1891.

Station 3202, off Santa Cruz, Cal., in 382 fathoms, mud; temperature 41.1° F. No. 122649, U.S.N.M.

CHRYSODOMUS (SIPHO) HYPOLISPUS, Dall.

Plate XXVII, fig. 1.

Chrysodomus (Sipho) hypolispus, DALL, *op. cit.*, p. 188, 1891.

Station 3254, in Bering Sea, north of Unimak Island, Aleutians, in 46 fathoms, mud; bottom temperature 36.2° F. No. 122606, U.S.N.M.

CHRYSODOMUS (SIPHO) ACOSMIUS, Dall.

Plate XXVII, fig. 3.

Chrysodomus (Sipho) acosmius, DALL, *op. cit.*, p. 188, 1891.

Station 3329, in Bering Sea north of Unalaska, Aleutians, in 399 fathoms, sand; bottom temperature 37.7° F. No. 122635, U.S.N.M.

CHRYSODOMUS (SIPHO) HALIBRECTUS, Dall.

Plate XXIX, fig. 9.

Chrysodomus (Sipho) halibrectus, DALL., *op. cit.*, p. 188, 1891.

Station 3330, in Bering Sea, north of the island of Akutan, in 351 fathoms, muddy bottom; temperature 37.8° F. No. 122603, U.S.N.M.

Subgenus ANCISTROLEPIS, Dall.

Shell buccinoid, with a short twisted canal; operculum straight, claw-shaped, concave, with apical nucleus; penis on a stout stalk with the distal extremity enlarged, foot-shaped, solid, without curved or attenuated point; dentition like *Chrysodomus;* laterals with a larger outer and two smaller inner curved cusps; median with three rather long, slender, subequal cusps, the anterior edge of the base concavely sinuate; the radula disproportionately small. Type *Chrysodomus eucosmius*, Dall.

This group differs from *Chrysodomus* in its shorter canal, peculiar operculum, and degenerate radula; from *Liomesus* and *Beringius* in its cuspidate rhachidian tooth and narrow claw-like operculum. It seems a characteristic Aleutian type.

CHRYSODOMUS (ANCISTROLEPIS) EUCOSMIUS, Dall.

Plate XXIX, fig. 7.

Chrysodomus eucosmius, DALL., Proc. U. S. Nat. Mus., XIV, p. 187, 1891.

Station 2919, near Cortes Bank, California, in 984 fathoms, mud; bottom temperature 38° F.; stations 3227 and 3502 north of Unalaska in Bering Sea, in 225 and 368 fathoms, muddy bottom; temperature 38.6° F., and in several other localities on the Alaskan coast, in 60 to 350 fathoms, and off the coast of Oregon and California; south to station 2923, off San Diego, Cal., in 822 fathoms. No. 122670, U.S.N.M.

The figured type is only 33 mm. in length, but specimens less well preserved reach over 50 mm. The area by which the operculum is attached to the body, as in *Strombus*, is quite small and the point of the operculum stands off from the body.

CHRYSODOMUS (ANCISTROLEPIS) MAGNUS, new species.

Plate XXIX, fig. 5.

Station 3254, in Bering Sea north of Unimak, in 46 fathoms, sand; and station 3255, near by, in 43 fathoms, sand; bottom temperature 37° F. Nos. 122674 and 122675, U.S.N.M. Also near the Pribilof Islands, in 59 fathoms; temperature 35° F.

Shell rather thin, with six whorls, covered by a thick pilose epidermis; whorls flattened or channeled near the suture and with a single strong keel at the shoulder, the surface covered with fine spiral threads crossed by rather prominent lines of growth; pillar short, normally much twisted and the coil pervious for one whorl, but some specimens attacked by annelids have it nearly buccinoid; aperture ample, the body with more or less callus laid over it, the outer lip not reflected; siphonal fasciole rather indistinct; operculum solid, black, rather short, concave, its outline like that of a half-shut fan. Height of shell, 75; maximum diameter, 50; length of aperture, 47 mm. Another specimen is 90 mm. in total length.

The substantial accordance of a second species in those characters which seemed to differentiate the first from *Chrysodomus* proper, decided me to institute the subgenus for them. The nucleus is more or less worn in all the specimens, but seems to be globular, regular yet swollen, and flattened at the summit.

STROMBELLA MELONIS, Dall.

Plate XXVIII, figs. 2, 3.

Strombella melonis, DALL, Proc. U. S. Nat. Mus., XIV, p. 187, 1891.

Station 3227, in Bering Sea north of Unalaska, in 225 fathoms, mud; bottom temperature 38.6° F. No. 122714, U.S.N.M. Also in 46 fathoms.

For those who reject the name *Strombella* the species here referred to it will, of course, be placed in the genus *Volutopsius*, Mörch.

STROMBELLA FRAGILIS, Dall.

Plate XXVIII, fig. 4.

Strombella fragilis, DALL, *op. cit.*, p. 187, 1891.

Station 3252, in Bering Sea north of the Aleutians, in 29½ fathoms, muddy bottom; temperature 44.8° F. No. 122710, U.S.N.M.

This species has since been received from stations 3251, 3253, 3254, and 3300, all in the eastern part of Bering Sea, in 15 to 50 fathoms, muddy bottom. It is very variable in its irregularities of plication and contour, but preserves a tolerably constant general aspect.

STROMBELLA MIDDENDORFFII, Dall.

Plate XXVIII, fig. 1.

Strombella middendorffii, DALL, *op. cit.* p. 186, 1891.

Station 3253, in Bering Sea north of the eastern Aleutians, in 36 fathoms near the Pribilof Islands; bottom temperature 35° F.; also on the south side of the Aleutians in the Pacific south of Unimak Island, in 61 fathoms, sand. No. 122709, U.S.N.M. This species is probably that which Middendorff referred to under the name of *Tritonium norvegicum*, to which the present shell bears a superficial resemblance.

Genus BERINGIUS, Dall.

Beringius, DALL, Sci. Res. Expl. Alaska, 1879, pl. II, legend. Proc. U. S. Nat. Mus. 1886, p. 304.

Jumala, FRIELE, Norwegian N. Atl. Exp. I, p. 6, 1882 (Type *J. Turtoni* Bean); Ann. N. Hist., Nov. 1893, p. 352, *olim*.

Ukko, FRIELE, in Norman, Ann. N. Hist., ser. 6, XII, p. 352, Nov. 1893.

The name *Beringius* was used by me in 1879 for the *Strombella* with edentulous rhachidian tooth, my type being *Chrysodomus crebricostatus*, Dall (1877). It was not defined until 1886, while in 1882 Friele applied and properly defined his name *Jumala*. In 1893, finding that *Jumala* is the word used by the Christian Lapps to designate the Deity, at Dr.

Norman's suggestion the name was withdrawn and *Ukko* proposed in its place. But, as I fully defined my genus *Beringius* in 1886, if *Jumala* for any reason fails, *Beringius* is prior to any subsequent name, and I therefore adopt it. It seems that when Herr Friele used the name *Jumala* he was under the impression that it was applied solely to one of their ancient pagan deities by the Lapps.

The following species probably belong to the genus *Beringius*, but I have not yet been able to examine the dentition.

BERINGIUS FRIELEI, new species.

Plate XXVII, fig. 8.

Station 3497, in Bering Sea near the Pribilof Islands, in 86 fathoms; temperature 38.7° F. No. 106988, U.S.N.M.

Shell resembling *B. Turtoni* in size, but with a more regularly tapered spire and deeper suture; the epidermis of a redder brown and not polished; very adherent; the sculpture is of close-set pairs of flattened spiral threads, each pair separated by a sharp channeled groove, as wide as a thread, from the next pair, and a very narrow but sharp groove between the two threads composing the pair; transverse sculpture only of fine incremental lines; nucleus lost; aperture snow white within; not lirate, though the external sculpture is reflected slightly close to the edge of the outer lip, which is slightly expanded; canal very short and wide; whorls six and one-half without the nucleus; operculum normal, very large, closing the aperture. Length of shell, 124; whorl, 80; maximum diameter, 55 mm.

This splendid shell differs from *Tritonium schantaricum*, Middendorff in being larger, in its paired sculpture and nonlirate throat. I suspect *T. schantaricum* belongs rather to the group of *Sipho spitzbergensis* than to *Beringius*. It is named in honor of Mr. Herman Friele, of Bergen, Norway.

BERINGIUS ALEUTICUS, new species.

Plate XXIX, fig. 2.

Station 3481, near Amukhta Pass, Aleutian Islands, in 248 fathoms, sandy bottom. No. 106999, U.S.N.M.

Shell of about five whorls (the nucleus is lost), solid, heavy, smooth, except for faint incremental lines and occasional obscure spiral streaks; whorls rounded, covered with a yellow-brown epidermis above the suture; the part anterior to the sutural line on the last whorl is marked by paler, opaque straw color; suture deep, not channeled; the pillar heavy, white, short; the siphonal fasciole, if any, removed by erosion; canal hardly differentiated from the aperture; pillar lip white, callous; outer lips smooth, simple, slightly expanded; length of (decollate) shell, 65; of last whorl, 48; maximum diameter, 36 mm. The operculum rather narrow, normal, and yellowish amber color.

This splendid species may prove not to be a *Beringius*, but I have not had an opportunity to examine the dentition, and it seems conchologically more like that genus than like *Sipho*.

MOHNIA FRIELEI, Dall.

Plate XXIX, fig. 8.

Mohnia Frielei, DALL, Proc. U. S. Nat. Mus., XIV, p. 186, 1891.

Station 2860, in the North Pacific off Queen Charlotte Sound, British Columbia, in 876 fathoms, green mud; bottom temperature 36.5° F. No. 122656, U.S.N.M.

This is the second species of Friele's interesting genus.

TROPHON (BOREOTROPHON) DISPARILIS, Dall.

Plate XXVII, fig. 4.

Trophon (Boreotrophon) disparilis, DALL, *op. cit.*, p. 189, 1891.

Station 3048, in the Pacific off Gray's Harbor, Washington, in 52 fathoms; bottom temperature 41° F. No. 122559, U.S.N.M.

This species has also been dredged in the Aleutian region; off San Diego, Cal.; at station 3431, in the Gulf of California off Mazatlan, in 995 fathoms, mud, bottom temperature 37° F.; and station 3392, in the Gulf of Panama, in 1,270 fathoms, hard bottom, temperature 36.4° F. (Nos. 123021–2, U.S.N.M.) This very remarkable range of distribution is explained by the temperature and the absence of any marked ridges in the sea bottom which might serve as barriers to southward migration. I see no reason why it might not be found all the way south to Cape Horn in water of the proper temperature.

TROPHON (BOREOTROPHON) SCITULUS, Dall.

Plate XXVII, fig. 5.

Trophon (Boreotrophon) scitulus, DALL, *op. cit.*, p. 188, 1891.

Station 3227, in Bering Sea north of the eastern Aleutians, in 225 fathoms, green mud; bottom temperature 38.6° F. No. 122557, U.S. N.M.

PUNCTURELLA MAJOR, Dall.

Plate XXVI, fig. 4.

Puncturella (galeata, GOULD, var. ?) *major*, DALL, *op. cit.*, p. 189, 1891.

Station 3262, in Bering Sea north of Akutan Island, in 43 fathoms, sand; temperature 41° F. No. 122543, U.S.N.M.

SOLEMYA JOHNSONI, Dall.

Plate XXV, fig. 1.

Solemya Johnsoni, DALL, *op. cit.*, p. 189, 1891.

Stations 3399, on the coast of Ecuador, in 1,740 fathoms; 2799, 3360, 3381, and 3382, in the Gulf of Panama, in 1,672–1,793 fathoms; 3010 and 3434, in the Gulf of California, in 1,000–1,588 fathoms, the temperature in all cases ranging between 35.8° and 36.4° F. No. 106886, U.S.N.M.

This species has since been dredged in the deep water of the Pacific as far north as the Straits of Fuca. It is named in honor of Prof. O. B. Johnson, of Washington University, Seattle, Wash.

CRYPTODON BISECTUS, Dall.

Plate XXVI, figs. 2, 5.

Cryptodon bisectus, DALL, Proc. U. S. Nat. Mus., XIV, p. 189, 1891.
Venus bisecta, CONRAD, Geol. U. S. Expl. Exp., p. 724, pl. 17, fig. 10, 1850.
Thyatira? bisecta, MEEK, S. T. checklist Mio. fos., p. 8, 1864.
Conchocele disjuncta, GABB, Pal. Cal. II, p. 27, pl. 7, fig. 48, 1869.

Station 2855, in the Pacific off the south coast of Aliaska Peninsula, in 69 fathoms, mud; temperature 44° F; also in Puget Sound in deep water, Prof. O. B. Johnson; and in the Miocene and Pliocene beds of Oregon and California. No. 122556, U.S.N.M.

CALYPTOGENA PACIFICA, Dall.

Plate XXV, figs. 4, 5.

Calyptogena pacifica, DALL, *op. cit.*, p. 190, 1891.

Station 3077, in Clarence Strait, Alaska, in 322 fathoms, mud; bottom temperature 42.4° F. 122549, U.S.N.M.

This shell is also found in the Tertiaries of California.

LIMOPSIS VAGINATUS, Dall.

Plate XXV, figs. 3, 6, 7.

Limopsis vaginatus, DALL, *op. cit.*, p. 190, 1891.

Station 3330, in Bering Sea north of the eastern Aleutians, in 351 fathoms, sand; temperature 38.2° F. Also in the Pacific south of Unimak Island, in 1865, at a depth of 80 fathoms, by W. H. Dall. No. 122547, U.S.N.M.

A rather eroded valve retaining the epidermis of this extraordinary shell was obtained with a sounding cup by me in Alaska about thirty years ago. The hinge being destroyed, I felt so much doubt as to its true character that it was left undescribed, and only when the fresh specimens of the *Albatross* were obtained was it possible to identify the earlier find.

Class BRACHIOPODA.

With the species obtained at the Hawaiian Islands I have included a few dredged by the *Albatross* elsewhere in the Pacific to avoid scattering data on this very interesting group.

Family RHYNCHONELLIDÆ.

Genus FRIELEIA, Dall.

Shell resembling *Hemithyris*, Orbigny, from which it is distinguished by having the inner upper margins of the crura extended toward each

other and united to the upper edge of a rather prominent median septum, forming a spondylium, and in having the brachia consisting of a much smaller number of coils. Type *Frieleia halli*, Dall.

FRIELEIA HALLI, new species.

Plate XXIV, figs. 6, 9, 10, 11, 12, 13.

Shell of moderate size, thin, translucent, yellowish gray, dorsoventrally somewhat compressed, slightly impressed in the median line below, but the basal margin hardly, if at all, flexuous; surface smooth, polished, except for faint, irregular radial markings and delicate incremental lines, occasionally modified by accidents of growth; pedicle valve pointed above, rounded at the lower corners, with a sharp, short beak slightly recurved, below which is a nearly circular peduncular orifice, bounded below by two well-marked subtriangular deltidial plates, which do not quite meet in the median line; cardinal margin below them evenly arched and passing without an angle into the lateral margins of the valve, which for some distance are almost straight; the margins then round evenly into the base, which in many specimens is nearly straight, in others slightly excavated mesially; the whole of the margins are nearly in one vertical plane; teeth much as in *Hemithyris psittacea*, short, stout, projecting at right angles to the plane of the valve margins, and slightly recurved, below supported by slender buttresses, which rise from the valve and extend upward into the cavity of the beak, leaving narrow recesses between the buttress and the side of the valve; in the interior of the beak there is no mesial septum, and the thinness and translucency of the polished valve are such that hardly any trace of muscular impressions is left on the shell; these impressions, if visible, would extend only three-fourteenths of the distance from the cardinal margin toward the base of the valve, while in *H. psittacea* the proportion is about eight twenty-firsts; the interior of the valve under moderate magnification shows with great clearness the reticulated outlines of the prisms of shelly matter forming the internal layer of the shell, but there are no other internal markings; brachial valve hardly less inflated than the other, roundly pointed above, with a well-defined, slender, sharp-edged medial septum extending six-fifteenths of the distance from the cardinal apex toward the base; teeth long, diverging at an angle of about 120°, obliquely transversely striated, the sockets behind them deep, internally transversely grooved; lamella supporting the teeth deep seated, extending obliquely from the sides of the valve; crura starting from the cardinal margin at the inner ends of the teeth, extending in a straight line obliquely downward and forward, united to the teeth for about half the whole length by an excavated lamina; the free ends of the crura slightly wedge shaped, parallel sided, and abruptly truncate at the ends. From the upper part of the inner edges of the crura on each side an excavated lamina is given off, which

reaches the median line above the septum, to which and to each other the laminæ are solidly attached, forming a narrow spondylium. The front edge of the spondylium is indented mesially and there is an impressed mesial line extending upward, on each side of which, in old specimens, the laminæ are made prominent by a callous deposit. Behind the spondylium the attached surface of the septum is widened, so as to support part of each lamina as well as their line of junction. On either side of the septum, between it and the supporting dental lamina, a pointed recess extends below the spondylium toward the cardinal margin. The surface of this valve, like that of the other, is too polished to retain much of the muscular impressions. The muscles, however, are inserted on each side of the septum and above its lower end, much as in *H. psittacea*. An average specimen measures 17 mm. high, 16 mm. wide, and about 10 mm. in antero-posterior diameter.

Stations 2871, 2919, 2923, and 2929, in 559, 984, 822, and 623 fathoms, from latitude 47°, off Grays Harbor, Washington, to the Pacific Ocean off San Diego, Cal., on a bottom of fine mud and sand, attached to dead *Echinus* spines. Bottom temperature 38° to 39° F. No. 123148, U.S.N.M.

The species is named in honor of Prof. James Hall, State geologist of New York, whose contributions to our knowledge of the brachiopoda are second in importance only to those of the late Thomas Davidson. The name which I have adopted for the genus is given in honor of Herman Friele, esq., of Bergen, Norway, to whom we owe the proof of the remarkable features which characterize the development of the long-looped Terebratuloids.

The anatomy of *Frieleia* when compared with that of *Hemithyris* presents few essential points of difference. The brachia are very delicate and make only about four turns. The base upon which they are inserted is circular, forming, when dilated, a cylindrical tube. The cirrhi alternate, as in *Hemithyris*. The number of coils is about four, which is very much fewer than in *H. psittacea*. The attachments of the muscles are relatively much the same in the two groups, but in *Frieleia* the muscles are smaller and their points of insertion on the body of the valve rather posterior, none exceeding the limit indicated by the point of the septum. The ovaries recall those of *H. psittacea*, but are less extensive. They are of a yellowish-white color. The nephridia are four in number, situated essentially as in *Hemithyris*, but more delicate, smaller, and paler than in *H. psittacea*. The end of the intestine forms a small bulb, slightly inclined to one side, but not as lax or as large as in *H. psittacea*. The blood sinuses are quite narrow, but in general distributed much as in the last-mentioned form. The mantle edge is very thin, very sparsely furnished with short setæ, which appear perfectly smooth, transparent, and very sharply pointed, but under a high power show regular transverse markings. The peduncle is short and of a brownish color. There were several of the specimens dredged alive

which had closed their valves on the tips of the brachia, confirming the observations of Morse that these organs may be protruded beyond the valves. Fischer reports the same fact with regard to *Hemithyris cornea*, dredged off the African coast by the *Talisman.*

The differences which separate this group from *Hemithyris* are sufficiently obvious, though perhaps they would have been regarded formerly as of not more than subgeneric rank. When the closeness with which the lines have been drawn among the fossil genera are considered, the relative rank of this one seems fully generic. The nearest relative of *Frieleia* among fossil *Rhynchonellidæ* is probably to be found in the genera *Camarotœchia* and *Leiorhynchus*, Hall, a plicated group of forms which flourished in the middle and later Devonian and early Carboniferous periods. In the former the crural laminæ, separate in the young state, are united by the deposit of callus on a cup-like expansion of the medial septum in the old individuals. In the very young *Frieleia* the crura lie on the summit of an arch of which one limb joins the side of the valve and the other unites with the keel of the septum, leaving a triangular surface of which the apex is on the septum, the base formed by the cardinal margin and the sides by the inner limbs of the two arches. As the shell grows this condition is modified, so that the anterior edge of the incipient spondylium is free from the septum and overhangs it. In well-developed full-grown specimens the suture of the spondylium is entirely coalescent and the separation indicated only by the notch in the front edge and the groove on the upper surface. In young or imperfectly developed adolescent specimens the notch may be, and frequently is, deeper; but in none, young or old, does the connection with the septum fail or is the suture fully open to the cardinal border. The thickening due to age sometimes almost develops a cardinal process on the apex of the brachial valve. As in all articulate brachiopods, the comparative elongation and inflation, or widening and compression, varies with different individuals. One specimen has the peduncular foramen completely closed in the median line below. Another, owing to some accident in youth, has a deep mesial groove in both valves from about the middle of the shell, giving the specimen almost the look of a *Bilobites.* Another has repaired the damage done by an extensive fracture with a sheet of shell substance, which shows that the secretion of shelly matter is not confined to peripheral parts of the mantle. The prismatic structure of the new shell deposit is similar in all respects to that of the old. Many of the shells are bored by an agency which produces results like the borings of *Cliona.* The shells are very free from sessile organisms, only a few Polyzoa or arenaceous foraminifera being observed. A few dead valves were noticed which seemed to have been pierced in the visceral region by some carnivorous gastropod, a misfortune from which brachiopods as a rule are remarkably free.

Genus HEMITHYRIS, Orbigny.

HEMITHYRIS BEECHERI, new species.

Plate XXXI, figs. 1, 2, 3, 4.

Shell nearly white, smooth, marked only by faint lines of growth, much inflated, wide, short, with a very deep wide median sinus in the front margin of the brachial valve and a corresponding projection of the pedicle valve; brachial valve with a much incurved apex and no median septum, though in an old specimen the deposit of shelly matter between the muscular impressions may give rise to an obscure prominence simulating a septum; teeth strong, the sockets long, deep, deeply transversely grooved, crural plates excavated, divided to the apex in the medial line; height of brachial valve, 15.5 to 16; width, 16.5 to 19 mm. The depth of this valve is about 12 mm.

Station 3473, in 313 fathoms off Honolulu, Hawaiian Islands. No. 107009, U.S.N.M.

Although only three brachial valves and some fragments of this species were collected, from which the slender crural processes were broken, there is no doubt that the material represents a new species. The only species with which it need be compared is *H. lucida*, Gould, which is a relatively much narrower, more compressed, and less flexuous shell of a very much smaller size. It is Japanese in habitat, as far as yet known, and is peculiar in having, normally, the foramen completely closed below by deltidial plates. Judging by the lines of growth, which agree on all the specimens, the proportional width of *H. Beecheri* is quite as great in the young as in the adult, but the young of the size of adult *H. lucida* would exhibit no mesial flexure worth mentioning.

The species is named in honor of Prof. Charles E. Beecher, of Yale University, whose contributions to our knowledge of brachiopoda are well known.

HEMITHYRIS CRANEANA, new species.

Plate XXXI, figs. 5, 6.

Shell small, translucent gray, very thin, with a flexuous anterior margin and almost smooth surface; lines of growth faintly indicated and by close inspection with a lens occasional irregular, radiating, very slightly elevated markings (such as occur more or less on all shells usually called smooth) may be discerned on the polished surface; pedicle valve pointed above, with the sides slightly rounded and the basal margin slightly concave; this valve is rather more inflated than the brachial valve, but not extremely so; foramen subtriangular, wide below, the deltidial lamellæ obsolete; teeth small, very short, cross-striated, and close to the foramen; cavity of the valve smooth; the muscular impressions have left no trace, but they are crowded close up under the foramen; there is no indication of a septum. Brachial valve rounded-triangular, the basal margin gently, evenly arched upward; a feeble mesial septum about one-third as long as the valve separates

the hardly visible muscular impressions, which are all above the lower end of the septum; armature of the hinge diminutive and feeble; teeth strong for their size, with very short sockets behind them; crural laminæ concave, the crura short, thin, spatuliform, with their broad sides parallel with the antero-posterior plane of the shell, their distal ends broader, rounded, not denticulate; the crura are separated clear to the cardinal margin; there is no obvious cardinal process. Length of shell, 16; width, 14; antero-posterior diameter, 9.25 mm.

Station 3362, in 1175 fathoms, mud, off Cocos Island, Gulf of Panama; bottom temperature 36.8° F. No. 122861, U.S.N.M.

A single specimen of this modest little species was obtained. The only species with which it need be compared is *Rhynchonella cornea*, Fischer, which is regularly finely striated and has a more angular outline and less flexuosity at the base. The minor details of the crural plates and crura are also different. *Hemithyris lucida* is much more flexuous in front than the present species. In short, although its characteristics are in no respect striking, this little form can not be united with any other yet described. It is respectfully dedicated to Miss Agnes Crane, the editor of Dr. Davidson's posthumous papers on Brachiopoda, to whose care and energy the students of Brachiopoda are much indebted.

Family TEREBRATULIDÆ.

Subfamily TEREBRATULINÆ.

Genus TEREBRATULA (Llhwyd) Auctorum.

Subgenus LIOTHYRINA, Oehlert.

LIOTHYRINA CLARKEANA, new species.

Plate XXXI, figs. 9, 10.

Shell small, thin, perfectly smooth, polished, of a very pale translucent straw color, rather convex, of suboval outline, conspicuously punctate; pedicle valve with a short beak and rather large not quite complete foramen, on either side of which is a wide, subtriangular deltidial area; the inner slopes of these triangles form the lower edge of the foramen, their bases the cardinal border, their inner angles nearly touch and are united by a cartilaginous deposit; teeth short, strong; cardinal border arched; sides rounding evenly into the rounded basal margin which recedes slightly from the plane of the lateral margins, but is not flexuous; cavity of the valve without any septum, the muscular impressions not conspicuous, situated in the upper fifth of the valve; brachial valve flatter, with a minute but distinct cardinal process, strong teeth and small short incomplete loop; in the cavity of the valve is a very feeble elevated line which may be regarded as a median septum, but which does not reach the apex of the valve and extends forward only as far as the adductors. Height of the shell, 12; width, 10; diameter, 6 mm.

Station 3362, in 117.5 fathoms, mud, off Cocos Island in the Gulf of Panama; bottom temperature, 36.8° F. No. 107275, U.S.N.M.

A single specimen of this modest little shell was obtained. It differs from *L. davidsoni*, Adams, in its incomplete foramen and less flexuous margin; it is less inflated and somewhat smaller. From the young of *L. uva*, Broderip, which is (notwithstanding it has been called "smooth") a finely regularly microscopically striate shell, it may be distinguished by its smooth surface. *L. arctica*, Friele, is less like it than *Davidsoni* is; and, in short, while the shell has no very marked characters, it can not be safely referred to any described species. Though small, by the solidity of its hinge armature and the manner in which the foramen is worn by the peduncular motion, it would seem to be an adult shell.

Though the shell was in a dry condition when taken up for study, the soft parts were well preserved, and present the peculiarity of having the lateral bands of brachia quite close to one another and rather long; the space between them is smooth and occupied by a stretch of membranous tissue, while the central whorl of brachia is below, and, looking vertically down upon the valve placed horizontally, is invisible, the cirrhi, of course, being contracted by drying. It is only on looking sidewise at the valve that the coil is seen under the membrane above mentioned and lower than the lateral brachial loops. On soaking the remains in fresh water they expanded considerably and assumed a fairly natural elasticity, but the relative position of the median brachial coil remained the same. The external appearance of this shell is almost exactly like that of *Macandrevia cranium* of the same size. The species is named in honor of J. M. Clarke, esq., associate of Prof. Hall in the revision of the Paleozoic Brachiopoda.

It is not likely that this species can be related to *Liothyrina stearnsii*, Dall and Pilsbry, which is a native of Japan (pl. XXX, figs. 8, 9, 11), as that species has a complete foramen, but the figures are given for comparison with the other species.

Genus TEREBRATULINA, Orbigny.

TEREBRATULINA CAPUTSERPENTIS, Linnæus.

Plate XXXII, figs. 2, 5.

Terebratulina caputserpentis var. *unguicula*, DAVIDSON, Mon. Rec. Brach. Pt. I, p. 25, 1886.

Terebratula unguicula, CARPENTER, Proc. Zool. Soc., 1865, p. 201, figs. 1–4.—DALL, Am. Journ. Conch., VI, 1870, p. 102.

Stations 2849, 3311, 3330, 3350, and many others, in from low water to 500 fathoms, temperature 40° to 44° F., from the southern part of Bering Sea southeast to the coast of California in latitude 33° N., and southwest to Japan and Korea. Also the North Atlantic, the upper Tertiary rocks of Europe, etc. Figured specimen No. 123155, U.S.N.M.

For some time I was disposed to regard the North Pacific form as

distinct from that of the Atlantic, following Carpenter, like whom I had only the stunted specimens from shallow water. But the deep-water dredgings of the *Albatross* having supplied a sufficient series of normally grown specimens of all ages and sizes, I have convinced myself, after a thorough comparison of many specimens from each region, that there is no good ground for a separation of them, even varietally. The Pacific form is the typical *T. caputserpentis* (not the eastern American *septentrionalis*) and neither in the shells nor in the soft parts does there appear to be any marked or constant difference. They could not be separated if once mixed in the same tray.

TEREBRATULINA KIIENSIS, Dall and Pilsbry.

Plate XXXII, figs. 8, 9.

Terebratulina (*unguicula*, CARPENTER *var.?*) *kiiensis*, DALL and PILSBRY, *Nautilus*, V, p. 18, pl. 1, figs. 4, 5, 1891.

Stations 2871, 3316, and 3205, in 559 fathoms, off the entrance to Fuca Strait; in 309 fathoms off the island of Unalaska in Bering Sea; and in 240 fathoms off Santa Cruz, Cal.; temperature, 38° to 44° F. Also from the coast of the province of Kii, Japan, Stearns; and from the Philippine Islands, NE. from Mindanao, in 82 fathoms, *Challenger* expedition. Figured specimen No. 128463, U.S.N.M.

This fine brachiopod, which when young approaches closely some broad varieties of *T. caputserpentis*, is shown by the *Albatross* material to be a distinct species. It may be known by its rounder outline, larger size, and the fact that the sculpture of the peripheral parts of the shell becomes obsolete, and is represented by grooves with flattened, much wider interspaces, instead of the rounded threads, characteristic of the surface of *T. caputserpentis* at all ages, and *T. Kiiensis* when young. The extension of its range, made known by the *Albatross* dredgings, is very remarkable and interesting.

Family TEREBRATELLIDÆ.

Genus EUDESIA, King.

This name was proposed at the same time as *Waldheimia*, King (=*Magellania*, Bayle), which was discarded as preoccupied. Subsequently it has been treated as a subgenus of the newer name *Magellania*. Beecher has shown that the austral forms typified by *Magellania*, on account of their different development, must be separated in a different subfamily from those of the northern hemisphere. *Eudesia* belongs with the latter. These again are separable into at least two generic groups, *Dallina*, of Beecher (apparently a descendant of *Antiptychina*, Zittel), which includes those with a continuous cardinal plate, strong median septum in the brachial valve, and no buttresses to the teeth of the pedicle valve. The other group comprises *Eudesia* and *Macandreria*, and has the cavity of the pedicle valve under the hinge separated into three cavities by two buttresses which support

the teeth. In the brachial valve the cardinal plate is divided medially by a sinus. The cardinal process is obsolete, and the medial septum either wholly absent or represented only by a short, low ridge not attached to the cardinal buttresses, and not extending forward into the cavity of the valve between the buttresses. As *Eudesia* is much the older name it must be retained for these forms, unless *Macandrevia* exhibits characters strong enough to give it generic independence. So far as known, the only differences between them consist in the smooth surface of the valves and the feebleness of the brachial septum in *Macandrevia*. These can hardly raise the latter above subgeneric rank, as the plication of the valves is often inconstant in the same species, while the same species (and doubtless the same individual) at different ages will show a septum more or less developed, from quite obsolete in the young, to quite perceptible in the senile stage. I have verified this on the type of *Macandrevia*, though the septum is never prominent. If the beak of the brachial valve of an old individual were to be ground off, a septum would be perceptible there very much as figured by Oehlert for the beak of *Eudesia cardium*. Consequently I feel obliged to regard *Macandrevia*, at least for the present, as forming merely a subgeneric group under the genus *Eudesia*. As regards the partly austral species about to be described, since there is no means of deciding whether their development agrees with those forms referable to Magellaniinæ or not, and as the adult shells exhibit no characters which could be regarded as diagnostic of a genus different from *Eudesia*, I feel obliged for the present to refer them to that group. It may be observed that there is nothing to prevent the free migration of northern forms into the south Pacific along the coast of the Americas. The writer has already the evidence to show that several species, in deep water, do extend from Bering Sea south to the vicinity of the Galapagos Islands and, in the case of one species, *Solemya johnsoni*, Dall, more than a thousand miles farther south, with the known great range of many brachiopods, there would be no apparent reason why species of the Panamic region, for instance, belonging to the northern type of development should not extend their range southward, if opportunity arose. I regard it then, as quite likely, that the species I refer to may be Macandrevian in their development as well as in their adult state, though, for the mass of characteristically austral species, the reverse might be the case.

Subgenus MACANDREVIA, King.

Type *Terebratula cranium*, Müller.

MACANDREVIA AMERICANA, new species.

Plate XXXII, figs. 1, 4, 7.

Eudesia fontaineana, DALL (not ORBIGNY) Proc. U. S. Nat. Mus., XII, 1889, p. 231.

Shell of moderate size, rounded ovate, brownish white, smooth externally except for numerous incremental lines best visible under a lens; margins not flexuous; pedicle valve moderately arched, thin, with a

recurved short beak, rather large foramen incomplete below to the extent of about one-fourth its circumference, with a small obsolete deltidial plate on each side; teeth strong, short, supported each by a strong buttress with a recess behind it, and in old specimens with a smooth deposit of callus on the surface of the valve between the two buttresses; no median septum, the muscular impressions faint, situated in the upper fourth of the valve; brachial valve flatter, orbicular, with a small very low cardinal process produced downward, three times its width, on the surface of the beak between the crural plates, as a low ridge rounded above; crural plates strong, supported by buttresses for half their length, rather close together, supporting a thin delicate brachidium, longitudinally grooved near and at the recurvation, with a few spinules on the outer edge, the hæmal border of the bight of the loop showing a small projection opposite the crural process of each side, the brachidium reaching three-fourths of the distance from the cardinal border to the basal margin and over all one-third as wide as the valve; pallial sinuses following much the same course as in *M. venosa* but straighter, less branched, and of a whitish instead of reddish brown color. Height of shell, 22; width, 19; diameter, 9.5 mm.

Station 2783, in 122 fathoms mud, bottom temperature 48°F., off the west coast of Patagonia, in latitude 51° 2′ south; and station 3360, in 1672 fathoms, sand, temperature 42°F., in the Gulf of Panama. Nos. 87547 and 122859, U.S.N.M.

When first examined one of these specimens was erroneously supposed to be the young of *Terebratula fontaineana*, Orbigny, a species which should doubtless be referred to *Magellania venosa*, Solander, as a synonym. Later and more careful study of a second specimen has enabled me to correct my mistake. From the young of *M. venosa* the incomplete foramen enables it to be discriminated, without examining the interior of the shell. In a general way this species looks very much like an adolescent specimen of *Laqueus jeffreysii*, in general outline, but is flatter.

MACANDREVIA CRANIELLA, new species.

Plate XXX, fig. 1.

Shell much resembling in size and form the specimen figured by Davidson,* below referred to, but rather more rectangular with a less prominent beak, and a narrower and more slender brachidium. Surface of shell smooth, except for numerous strong concentric lines of growth and prominent punctation. Under a lens a microscopic radial sculpture is visible on parts of the shell, resembling the fibrous surface of a worn *Rhynchonella* rather than regular striation. Form of shell rounded, rectangular, with a low beak and large foramen; pedicle valve rather inflated, the side and basal margins slightly excavated, the basal corners rounded but slightly prominent, from which the obscure rectan-

*See *Macandrevia* sp., DAVIDSON, Mon. Rec. Brach., I, pl. XII, fig. 13, 1889.

gularity of the shell arises; teeth strong, foramen large, incomplete, the deltidia almost linear, but long; dental buttresses strong, receding as they approach the arch of the valve; brachial valve flatter; teeth strong, with very oblique buttresses; brachidium four-fifteenths the length of the valve, barely one-third as wide as the valve, slender, with a single spine at the point of recurvation, and a slight thickening, but no septum, at the cardinal apex; muscular impressions small and confined to the upper fourth of the valve. Height of shell, 17; width, 12; diameter, 9 mm.

Station 3362, in 1,175 fathoms, mud; temperature, 36.8° F.; in the Gulf of Panama. No. 122858, U.S.N.M.

This species resembles *Magellania* (*Waldheimia*) *wyvillei*, Davidson, but wants the septum and cardinal process of the brachial valve of that species, which also has less oblique, shorter, and wider deltidia. It has much resemblance also to *Macandrevia cranium*, but is a more rectangular, plump, and compact shell, and appears not to reach the size of *M. cranium*. *M. tenera* has a shorter loop and more obvious septum in the apex of the brachial valve. It is also a smaller species when adult.

MACANDREVIA DIAMANTINA, new species.

Plate XXX, fig. 5; plate XXXII, figs. 3, 6.

Shell smooth polished, dorso-ventrally compressed, flexuous, of a rounded lozenge or "diamond"-shaped outline; surface with faint incremental lines, but no radial sculpture, waxen white; pedicle valve subpentagonal, widest near the middle, the converging sides below produced, the basal margin concave; beak short, wide, the foramen incomplete below, with well-developed deltidia on each side; teeth strong, supported by wide buttresses, forming wide recesses on each side; muscular impressions indistinct, situated in the upper third of the shell; no median septum exists in this valve. The genital glands are of a reddish brown color, shining through the shell as two short parallel streaks on each side of the adductor impressions; brachial valve wider than high, with the base flexuous upward; teeth strong, with very oblique buttresses hidden under the dental plates and forming small foveolæ; cardinal process short, stout, prominent, but not produced into a septum; brachidium very slender, extending to the basal third of the valve, the transverse limb at the bight of the loop being wider than any part of the lateral limbs, the bight itself being, of course, narrower, as usual; there are two or three spinules at the recurvation; the genital glands in this valve show as a single brown streak on each side of the attachment of the adductors. It is, however, longer than the paired streaks of the pedicle valve. Height of shell, 18; width, 17; diameter, 7 mm.

Station 3362, in 1,175 fathoms, mud; temperature, 36.8° F.; in the Gulf of Panama. No. 122860, U.S.N.M.

This elegant little species recalls *Liothyrina wyvillei*, Davidson, in its form, though more lozenge-shaped and less sharply flexuous.

It is sufficiently distinct from all described recent species to make no comparisons necessary. Only two specimens were obtained.

? MACANDREVIA ———.

At station 3476, in 298 fathoms, near the port of Honolulu, a single specimen of a brachiopod in the cistelliform stage was obtained. It is, of course, too young to determine the species or even the genus to which it belongs. However, it may pretty certainly be stated that it is not a young stage of the common Hawaiian species usually known as *Ismenia* or *Muhlfeldtia sanguinea*, Chemnitz,* and probably indicates the presence of a species in the Hawaiian fauna which has not yet been enumerated from it. In this connection an apparent misapprehension may be corrected. The name *Frenula* was proposed by me in 1871 for a brachiopod, which I named subsequently *Ismenia jeffreysi*, and which has since proved to be the ismeniform stage of *Laqueus vancouverensis*, Davidson. I joined with it the *Ismenia sanguinea* (Chemnitz) Gray, because of the identity of form of the brachidium in both. Gray had referred *Anomia sanguinea*, Chemnitz, to *Ismenia*, King (part). But it appears that the original *Ismenia* of King is not of this character, and the name must be kept for *Terebratula pectunculus*, Schlotheim, for which it was proposed. *Frenula* having been proposed for a young stage of my earlier subgenus *Laqueus* (type *Terebratula californica*, Koch) can not be applied to the species *sanguinea*, which represents in its adult condition the stage which in *Frenula* proper is only a phase of development. Both the loop and surface of the *sanguinea* differ distinctively from those of *Muhlfeldtia truncata*, and if they are placed in the same genus the former requires to be separated subgenerically. I would therefore propose for the *Anomia sanguinea*, Chemnitz, the subgeneric name of *Frenulina*, a conclusion in which the late Dr. Davidson acceded in letters received from him before his premature and lamented decease. By a *lapsus*, in a footnote to Beecher's Revision of the Families of Loop-bearing Brachiopods,† it is stated that "*Megerlina jeffreysi* was given to a stage of *Laqueus*," etc. Here *Frenula* is meant, *Megerlina* being based on *Kraussina lamarckiana* by Deslongchamps. It has also been stated by Oehlert‡ that *Frenula* was applied to a "stage of *Ismenia sanguinea*," an error doubtless inherited from an obscure remark by Deslongchamps to the same effect. These misapprehensions, I hope, will be cleared up by the statement of facts I have just given.

Genus LAQUEUS, Dall.

To the species belonging to this group may be added *T. blanfordi*, Dunker, of Japan. I have received some very fine adult specimens which show conclusively that this species has the loop of *Laqueus*.

* As Chemnitz was not strictly binomial in his nomenclature, it is probable that Gmelin's name of sanguinolenta should be adopted for this species.

† Trans. Conn., Acad., IX, p. 383, March, 1893.

‡ Fischer, Man. de conchyliologie, p. 1321.

Others obtained by Mr. Frederick Stearns in Japan showed the same features. The loop is a very solid one as a whole, but the connecting bands which unite the upper with the lower branches of the brachidium are narrow and rather frail; they had probably been lost in the specimen figured by Van Iterson in Part II of Davidson's Monograph, pl. XV, fig. 12.

LAQUEUS CALIFORNICUS, Koch.

Laqueus californicus (KOCH), DALL, Am. Journ. Conch., VI, p. 123, pl. VII, fig. f; pl. VIII, figs. 9, 10, 1870.

Off San Pedro in 30 fathoms, Oldroyd.

The original locality of this species is the coast of California. Cooper dredged specimens in the vicinity of the Santa Barbara Channel in 90 fathoms. It was on one of these that my earlier observations were based. Subsequently, from moderate depths of water, a smaller, somewhat stunted form was collected from the Queen Charlotte Islands and the coast of British Columbia. The color of the southern form is of a warm reddish brown and the shell is quite thin, the foramen small and delicate. The northern form is of a dirty livid yellowish white, or pale brown; usually it has a large foramen and heavier shell than the Santa Barbara shell. The latter, too, when compared with a large series, is wider near the cardinal border giving it a more rectangular form, while the northern shell is more attenuated, and the sides slope to the umbo in a straighter line from the point of greatest width.

The Queen Charlotte Island shell was separated by Davidson as a variety *vancouveriensis* (more correctly *vancouverensis*), but his specimens were stunted, being from relatively shallow water. The dredgings of the *Albatross* have shown that the northern shell also occurs in the south in the same region and depth as the typical *californicus* and without transitions in color and form. It will, therefore, be necessary to separate the two forms as distinct though allied species.

LAQUEUS JEFFREYSI, Dall.

Frenula jeffreysi, DALL, Am. Nat., v, p. 55, 1871 (ismeniiform stage). Am Journ. Conch., VII, p. 65, pl. XI, figs. 7–10, 1871.

Megerlia jeffreysi, DALL, Sci. Res. Expl. Alaska, p. 48, 1877.

Laqueus californicus var. *vancouveriensis*, DAVIDSON, Mon. Rec. Brach., p. 113, pl. XVIII, figs. 10–13*b*, 1887 (adult).

Stations 2862, 3194, 3339, 3350, etc., in 75 to 238 fathoms, from the Aleutian Islands to a point off Estero Bay near San Luis Obispo, Cal., the bottom temperatures varying from 37° to 48° F. The depth at which the species is found increases southward, but the temperature was highest off Point Arena, Cal., where several specimens were dredged in 75 fathoms. Fine specimens have also been collected in Puget Sound.

The small size of the specimens, first separated as a variety by Dr. Davidson, is due to their station. The *Albatross* in deeper water got specimens even larger than the original *californicus*, and from that to the earliest stages. These showed conclusively that the shell which I

had described under the specific name of *jeffreysi* is the ismeniiform stage of the shell afterwards named *vancouveriensis*.

The fact that specimens of *Terebratalia transversa* become more reddish and bright colored when living in the southern part of their range, and the stunted size of the first adult specimens of *jeffreysi* collected in the north, led me to regard them as belonging to a northern race of the ruddier *californicus*; but since specimens of *jeffreysi* from the vicinity of San Luis Obispo show no tendency to take on ruddy tints and preserve the characters of the northern specimens, though attaining an equal or even greater size than *californicus*, it is evident that the expected transition does not take place, and the form may properly be separated as a species (though nearly related to *californicus*) under the first name by which it was described and figured. Before the development of the loop in *Terebratellidæ* was fully understood, the similarity of certain specimens of the ismeniiform stage of *Dallina septigera* to those of *L. jeffreysi* led me to question whether the latter might not be common to the two oceans, but later when the various stages through which *D. septigera* passes became better known this suggestion was obviously not required to explain the presence of the supposed *Frenula* in the Atlantic Ocean.

The genus, or subgenus, *Laqueus* appears to be strictly confined to the shores of the north Pacific, where the following species occur:

JAPAN.	NORTHWEST AMERICA.
Laqueus pictus, Chemnitz.	*Laqueus jeffreysi*, Dall.
Laqueus blanfordi, Dunker.	*Laqueus californicus*, Koch.
Laqueus rubellus, Sowerby.	

Genus TEREBRATALIA, Beecher.

TEREBRATALIA OBSOLETA, Dall.

Plate XXX, fig. 7.

Terebratella occidentalis var. *obsoleta*, DALL, Proc. U. S. Nat. Mus., XIV, 1891, p. 186.

Terebratalia obsoleta, DALL, in BEECHER, Dev. *T. obsoleta*, Trans. Conn. Acad. IX, p. 392, 1893; type of genus.

Stations 2983 and 2984, in 58 and 113 fathoms, sand, northwest from Cerros Island, Lower California, and 3044 in 58 fathoms off Abreojos Island, Lower California; bottom temperatures, 50° to 56° F. Nos. 122545, 123140–'43, U.S.N.M.

Shell scarlet, radiately streaked with pale yellow, especially in the channels between the ribs; surface polished, smooth except for rather distinct incremental lines and, in adult specimens more or less distinct, partially obsolete radial ribs, which appear near the margin, but do not extend to the earlier half of the shell; in senile specimens a larger proportion of the shell is ribbed; pedicle valve with a rather low beak and wide, incomplete foramen; deltidial plates well developed but widely separated; valve wider (as a rule) below the middle, the

arch of the base cut into three subequal parts by two especially strong ridges (corresponding to channels on the brachial valve), between which the surface of the valve may be more or less ribbed radially, but is always flattened or depressed, corresponding to an upward flexure of the basal margin; teeth strong, supported by deeply receding buttresses; no medial septum; the adductors with widespread ends, rather distant from the medial line, confined to the upper third of the valve; pallial sinuses large, divaricating near the margin from five principal trunks on each side; the genital glands yellowish, extending in narrow bands along the sinuses nearly to their furcation; peduncle short, dark brown; brachial valve flatter, with a wide, low cardinal process, little prominent; teeth strong without buttresses, medial septum short, very thin and high, subtriangular; brachidium unusually slender; pallial sinuses numerous, much branched with a medial trunk nearly reaching the margin. Height of average specimen 30; width 30, diameter 17 mm. Old specimens attain a larger size. One dead pedicle valve measures 47 mm. high, 43 wide, and 20 mm. deep.

The varied forms which the brachidium assumes during development have been fully illustrated and described by Beecher in the paper already cited. The first specimens received were in poor condition, and it was thought possible that the species might be identical with *T. occidentalis*. Subsequently a fine lot of material from the vicinity of Cerros Island showed that the two species were perfectly distinct. *T. obsoleta* has no very near relative in the North Pacific. The colors recall the *T. coreanica*, *Laqueus pictus*, and *Frenulina sanguinea*, all quite distinct as to form. In form the nearest species is the *T. rubiginosa*, Dall, which is only known from the type in the National Museum, collected by the United States Exploring Expedition, and labeled as from the Cape of Good Hope. It is possible that this locality is erroneous, but the species has a different sculpture from *T. obsoleta*, and has only a faint reddish suffusion in the general brownish coloration. The peculiarly slender, rather wide, and arched brachidium is somewhat similar in the two species. It should be said that an occasional specimen of *T. obsoleta* has the foramen completed by a junction of the deltidia. *T. rubiginosa* is figured for comparison. Pl. XXX, figs. 3, 4.

TEREBRATALIA TRANSVERSA, Sowerby.

Plate XXXI, figs. 12, 13.

Terebratula transversa, SOWERBY, Thes. Conch., I, p. 261, pl. LXVII, figs. 114–115, 1846. Not of GOULD, 1860.

Terebratella transversa, DALL, Sci. Res. Expl. Alaska, p. 47, 1877; Proc. Acad. Nat. Sci. Phila., 1877, p. 157; DAVIDSON, Mon. Rec. Brach., p. 79, pl. XVI, figs. 6–12, 14, 14*a*, 1887 (*ex parte*).

Terebratula caurina, GOULD, Proc. Bost. Soc. Nat. Hist., III, p. 347, 1850; MOLL., U. S. Expl. Exp., p. 468, pl. XLIV, fig. 582, 1852.

Stations 2858, 2961, 2964, etc., in 10 to 230 fathoms, from the Aleutian Islands to Catalina Island, California. Oregon, United States Exploring Expedition.

This is the most common and variable species of the Northwest coast and attains a notable size, especially in the deep, quiet waters of Puget Sound. The original *transversa* was described from a rather smooth specimen, while Gould's type was strongly radiately ribbed. Dr. Davidson would use both names in a varietal sense, retaining the older for the species, but the grades of variation are so numerous that it is doubtful how far this would be justified, as it sometimes happens that one-half the shell is smooth and the other half ribbed. One feature, however, is constant in all the multitude of specimens I have examined; the flexure of the middle of the valves, though often feeble, is always concave in the brachial valve and convex in the pedicle valve. The young specimens from Monterey, Catalina Island, and other southern localities are frequently suffused with reddish or crimson about the margin and on the backs of the ribs. The ribs, when well developed and normal, vary from 18 to 40, bifurcating or intercalary toward the margin. The specimen figured is young, and chosen because it is of the same width as the specimen of *T. occidentalis*, with which it is intended to be compared, and also is, for the species, very strongly ribbed. These specimens are often found near extreme low-water mark, but it is probable that they never attain their full growth in such situations. The completely adult specimens appear confined to deeper water. They sometimes reach the size of 50 mm. high and 58 mm. wide, with a diameter of 31 mm. This species is figured in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1891 on pl. IV, figs. 6 and 7, but unfortunately the numbers in the text are 8 and 9, which refer to the figures of *T. occidentalis*. As in the text referred to, the attempt was made to separate the present species from *T. occidentalis*, which had become confused with it, this was doubly unfortunate, but as the writer saw no proof of the plate it was beyond his power to remedy. The present refiguring, it is hoped, will finally clear up the confusion.

This species is easily distinguished from *T. occidentalis* in the adult state if any attention be given to the diagnostic characters, but there are others from which it is less sharply distinguished. From *Dallina grayi*, Davidson, of Japan, the southern reddish specimens of *transversa* externally are with difficulty distinguished. In fact, one might fancy that the two species were descendants of one ancestor, which, for some reason, in Japan continued its evolution to the *Dallina* stage, while those in America ceased when they arrived at the *Terebratalia* stage. *D. grayi* in the adult stage has hardly any flexure, and in the variety *transversa*, Davidson, the flexure is double, but in the young, and in such of the adults as show the flexure clearly, the two medial riblets are convex in the brachial valve, complemented in the pedicle valve by a corresponding depression. In *Terebratalia transversa*, Sowerby, the flexure is wider, and the converse of what occurs in *D. grayi*. There is another *Terebratalia* in Japan with much the same sculpture as *T.*

transversa which has the flexure, though obscure, in the same sense as *T. transversa*. This is the *T. gouldii*, Dall,* of which, for comparison, figures are given (pl. XXX, fig. 2; pl. XXXII, fig. 10). *T. gouldii* was first described from a specimen in the *Magasella* stage, in 1871, but a comparison of specimens twenty years later showed that the adult form was a *Terebratalia*. But *T. gouldii* is a thinner and flatter shell, with the ribbing finer and more regular, as well as more distinctly marked, than in *T. transversa*. It is possible that future search may reveal *T. gouldii* on the American shores of the Pacific, as *Terebratulina kiiensis* has been found so distributed. At present only a few specimens are known. The color is of a livid grayish white, much like many specimens of *T. transversa*.

TEREBRATALIA OCCIDENTALIS, Dall.

Plate XXXI, figs. 7, 8.

Terebratella occidentalis, DALL, Proc. Cal. Acad. Sci., IV, p. 182, pl. I, fig. 7, 1871; Proc. Acad. Nat. Sci. Phila., 1873, p. 184, and 1891, p. 173, pl. IV, figs. 8, 9 (not 6 and 7).

Terebratella transversa, var. *occidentalis*, DAVIDSON, Mon. Rec. Brach., p. 79, pl. XVI, fig 13 (only), 1887.

Stations 2922 and 2981, in 45 to 47 fathoms, sand, off San Clemente Island, California, in 1889. Monterey, Catalina Island and vicinity, Dall, Cooper, and Canfield, chiefly from the beach. Nos. 401, 123144, and 95850, U.S.N.M.

This species is not known from north of Monterey. It seems to be a rare shell, and all the specimens yet examined are radiately ribbed with about ten very conspicuous ribs, more or less tinged with carmine, while the channels between them (and the body of the shell) are pure white. The mesial flexure is exactly the reverse of that in *T. transversa*, the brachial valve having it strongly convex, and the pedicle valve concave. The extreme dimensions yet observed are those of the specimen figured here; height 26, width 30, diameter 22 mm. The figures representing this species in the paper referred to under the last species were transposed with those representing *T. transversa*, as indicated in the synonymy.

EXPLANATION OF PLATES.

PLATE XXIII.

Fig. 1. *Halicardia flexuosa*, VERRILL, about twice natural size; diagram of the body from below; the mantle, *i, i, i′, i′*, severed and turned back to expose the parts; *a*, position of the anterior adductor; *p, p′*, adnate palpi; *f*, pedo-visceral mass, supporting the functional foot with byssal groove and the fin-like opisthopodium below (behind) it, and surrounded by the branchial septum; *s*, siphonal septum; *v*, circular valve of the incurrent siphon; *x*, cavity of the siphon; *c*, posterior commissure of the mantle lobes. Drawn by W. H. Dall; page 697.

* Proc., Phil. Acad. Sci., 1891, p. 167.

Fig. 2. *Euciroa pacifica*, DALL, about twice natural size; diagram showing a vertical cross section of the animal behind the foot; *o*, *ó*, subumbonal parts of the visceral mass, showing the superficial region occupied by the genital glands, between which are seen the dorsal mantle margin and the proliferations which enfold the teeth; *c*, pericardial chamber, with *h*, the ventricle of the heart lying over on the right side and partly hiding *v'*, the right auricle, while *v*, the left auricle, is fully exposed; below the ventricle is seen the rectum *r*, which here passes through the floor of the pericardium and is cut through in the nephridium below; *s*, *s*, cross section of the thick connective tissue formed by an infolding of the mantle below the pericardium, from the lower internal wall of which fine reticulated fibers radiate upward; this lamina would seem analogous to the free nephridial lamina in *Halicardia* (fig. 3, *s' n'*), but is attached to the visceral mass and shows a jelly-like solidity into which no ramifications of the ovary extend; below this descend the stems of the gills (with two tubular blood passages), supporting the transverse gill-laminæ, on the faces of which the radiating lines represent, not plications, but radiating muscular fibers seen through the transparent epithelium of the plates; the gill plates are represented as if laterally extended, but in life they extend obliquely backward so that an exact section would cut through a number of plates without showing their outline; the darkly-shaded spaces above the gills are the anterior portions of the anal chamber; *f*, the foot, above which is seen the circular section of the retractor muscle; *m*, *m'*, lobes of the mantle, showing columnar muscular fibers in section. Drawn by W. H. Dall; page 688.

Fig. 3. *Halicardia flexuosa*, VERRILL, magnified about four diameters, diagram of the vertical cross section of part of the body and gills, taken behind the foot looking toward the siphons; *d'*, dorsal junction of the mantle, below which is *r*, the rectum in section; *d*, subumbonal visceral mass; *o v*, the cavernous nephridium in which are seen *p*, *q*, the branches of the retractor muscles, and *c v*, cavities in the general mass of the partly glandular and partly fibrous tissue; *c r*, roof of *a p*, the posterior part of the anal chamber; *s*, downward continuation of the nephridium; *s'*, point where the free lamina is given off internally; *t m*, part of the downward continuation of the mantle lobe of the left side, cut away below *m*; *n*, free vermiform posterior termination of the lamina; *n'*, free edge of the lamina, more anteriorly; below and to the right of this is seen the junction of the lower surface of the lamina and the outer margin of *e* the outer lamina of the left gill; *z*, papilla on upper surface of the siphonal septum; *b*, severed stem of the left gill with blood vessel in section, the stem recurves and joins *b'*, that of the right gill near *j*, the point where both are soldered to the posterior keel of the foot; *c*, inner lamina of the left gill, extending between *j* and *b*, and forming part of the roof of the peripedal chamber. Drawn by W. H. Dall; page 697.

Fig. 4. *Euciroa pacifica*, DALL, about three times natural size; diagram of the animal from below, with *i*, *i*, *i'*, *i'*, the mantle severed and turned back to expose the parts; *a*, position of the anterior adductor; *p*, *p'*, the palpi; *f*, the foot surrounded by the coalescent gills; *s*, the siphonal septum; *x*, cavity of the incurrent siphon; below which are outlined the areas occupied by columnar muscular tissue and by dotted shading the glandular region of the mantle in front of the siphon. Drawn by W. H. Dall; page 688.

Fig. 5. *Halicardia flexuosa*, VERRILL; diagram of the heart and rectum much enlarged, for comparison with that of *Euciroa* (fig. 2, *h*, *v*, *v'*); *a*, the rectum passing through *v*, the ventricle, with, *l*, the left and, *r*, the larger right auricle. Drawn by W. H. Dall; page 697.

Fig. 6. *Halicardia flexuosa*, VERRILL, slightly enlarged; diagram of the soft parts removed from the shell, side view; *a*, median papilla above *b*, the anal siphon; *c–e*, the extremities of the pedal opening between the mantle lobes; the ends of the muscles are shaded. Drawn by W. H. Dall; page 697.

PLATE XXIV.

Fig. 1. *Spergo glandiniformis*, DALL; diagrams, *a*, *b*, *d*, natural size; *e*, slightly enlarged; *f*, about twice natural size; *h*, much magnified; *a*, front view of muzzle, showing relative position of tentacle; *b*, side view of animal crawling; *d*, front edge of foot from below; *e*, verge as it lies on the back of the animal with the point turned away from the head; *h*, teeth, the upper pair are placed in the natural position as they appear on the radula; the base of the tooth is shaded with dots; outside of it is a narrow fibrous band by which the teeth are attached to the radula; the blades are unshaded; from camera lucida sketches by W. H. Dall; page 680.

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Fig. 4. *Euciroa pacifica*, DALL, about natural size; diagram of the soft parts removed from the valves; *a'*, right end of anterior adductor muscle with *e* above it, being the end of the right branch of the protractor of the foot; *c*, area shaded to show the genital gland or ovary as seen through the mantle; *m*, surface of the area occupied by columnar muscular tissue between the surfaces of the mantle; *g–g*, extent of pedal opening between the mantle lobes; *a*, posterior adductor with below it at the mantle-edge the short siphonal retractor muscles. Drawn by W. H. Dall; page 688.

Fig. 5. *Euciroa pacifica*, DALL, much enlarged, diagram of the palpi and lappet; *s*, the double sacs above *p*, the anterior palpi; *l*, the fleshy median lappet; *p*, the posterior palp, folded on itself. Drawn by W. H. Dall; page 692.

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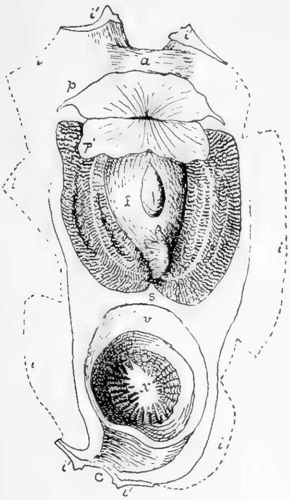

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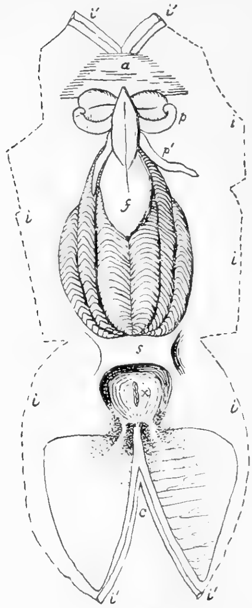

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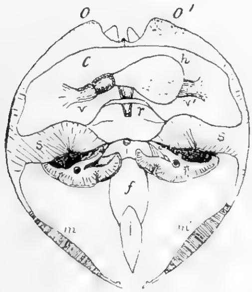

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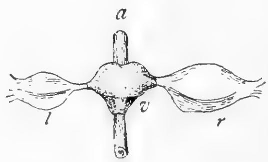

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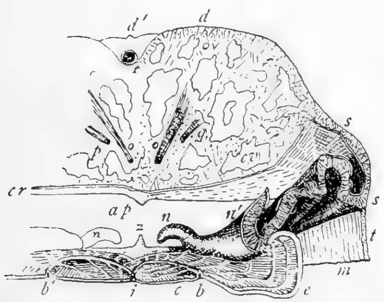

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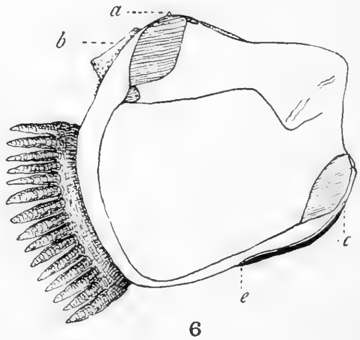
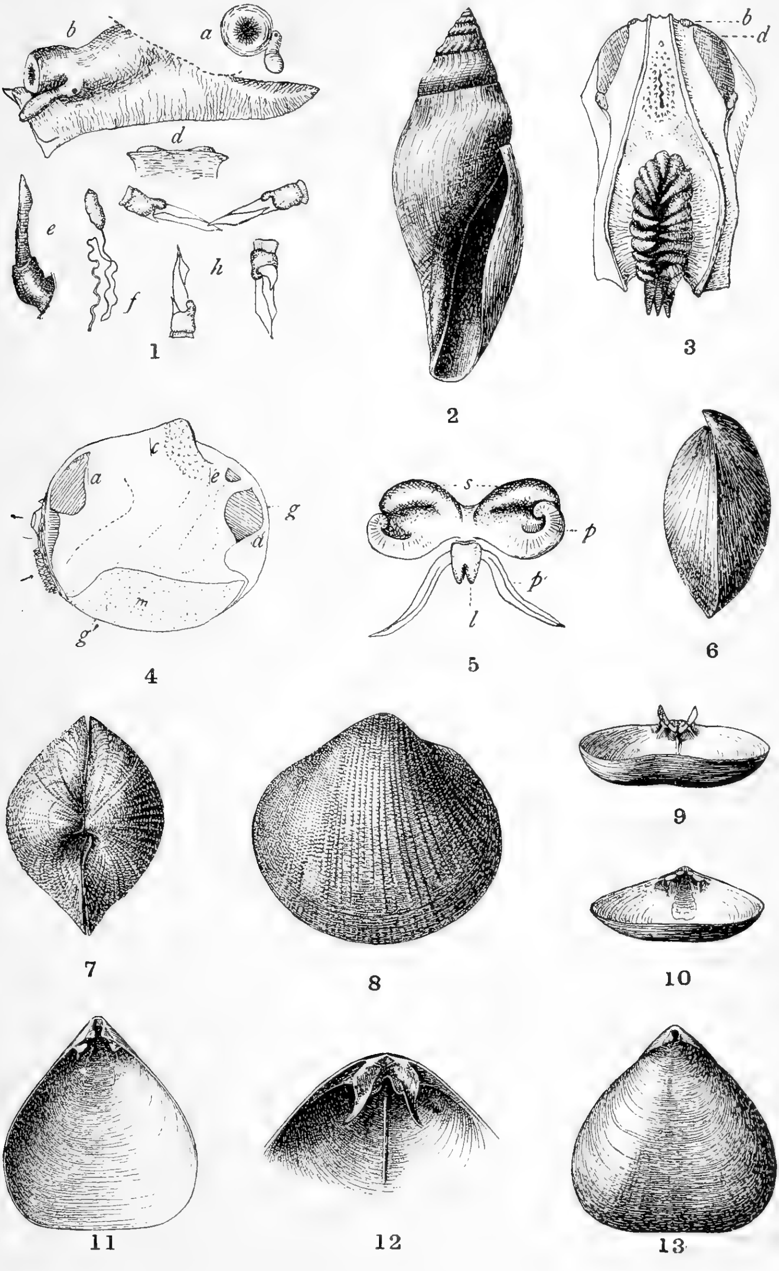


6

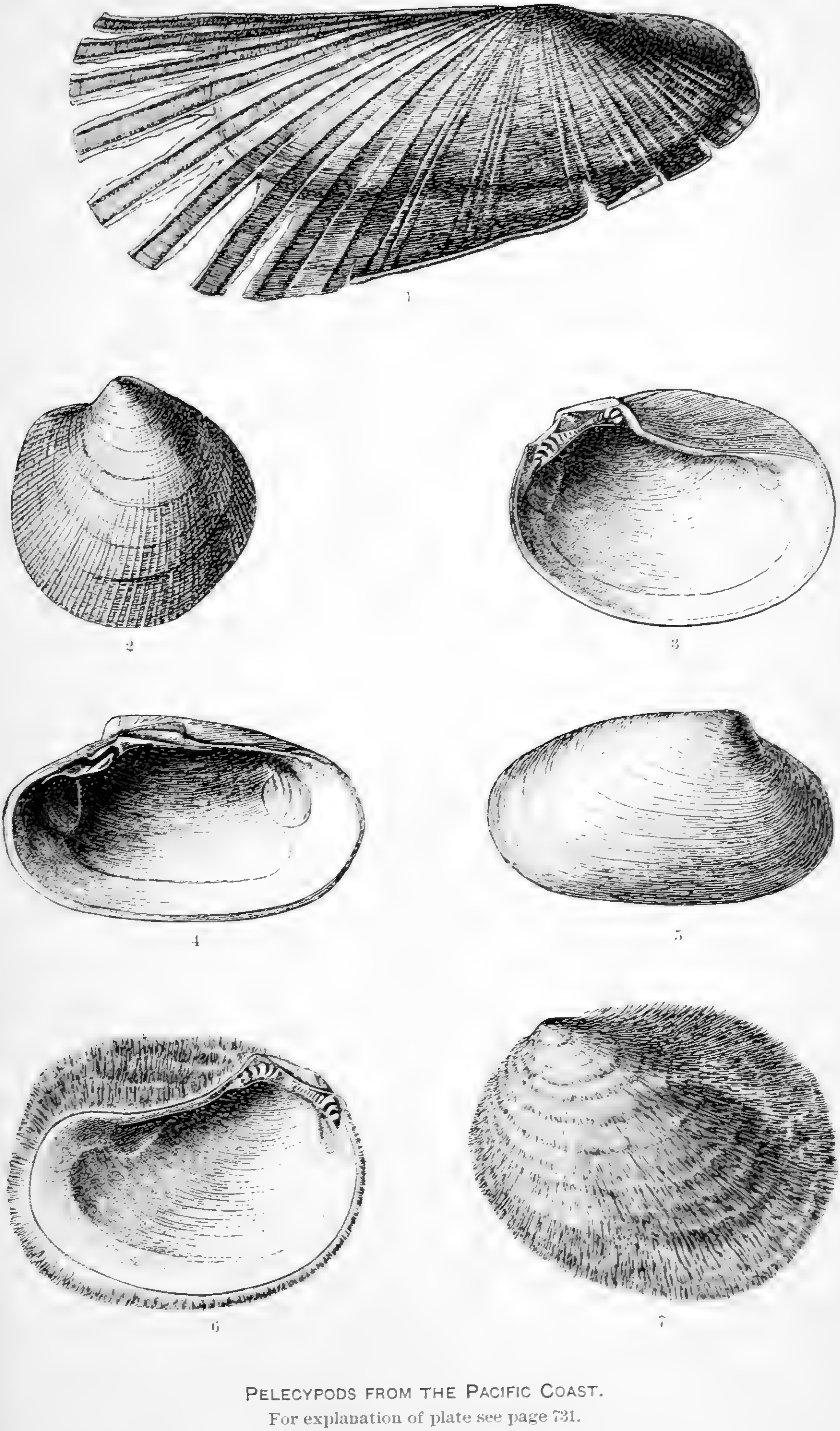
ANATOMY OF HALICARDIA AND EUCIROA.

For explanation of plate see page 729.



PACIFIC SHELLS AND BRACHIOPODS.

For explanation of plate see page 731.



PELECYPODS FROM THE PACIFIC COAST.

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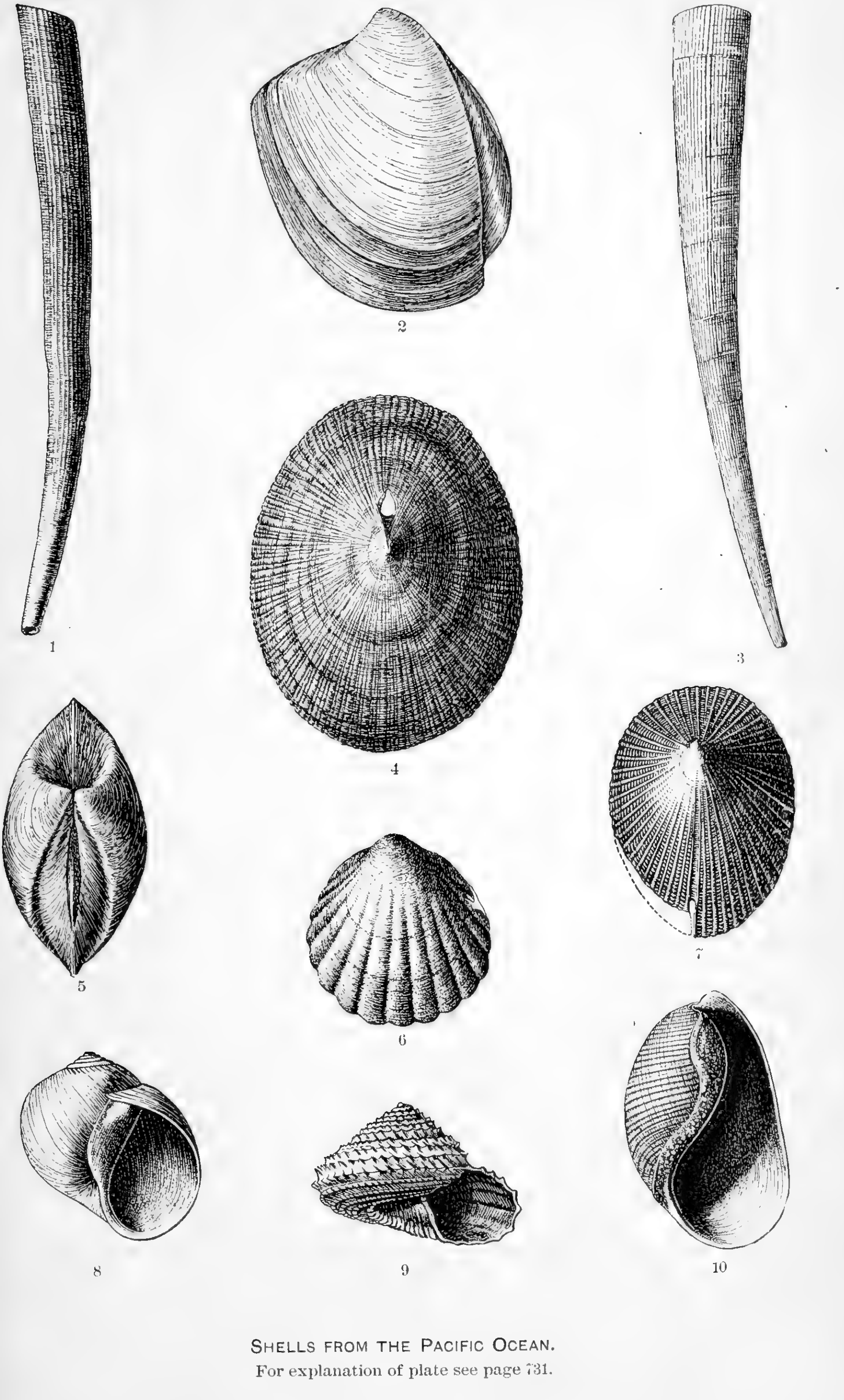
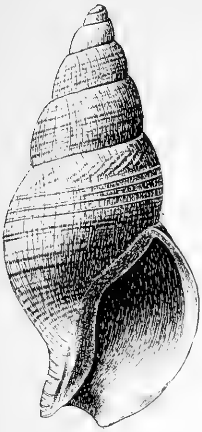


SHELLS FROM THE PACIFIC OCEAN.

For explanation of plate see page 731.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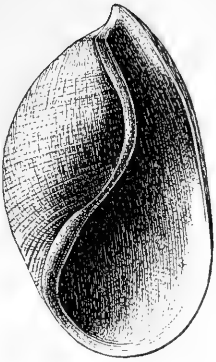
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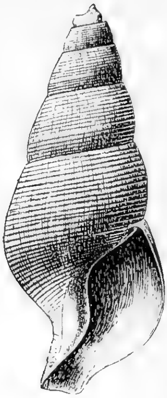
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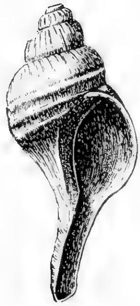
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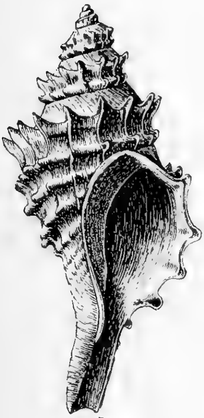
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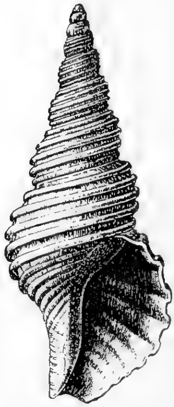
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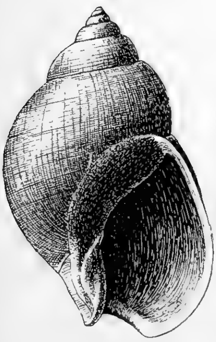
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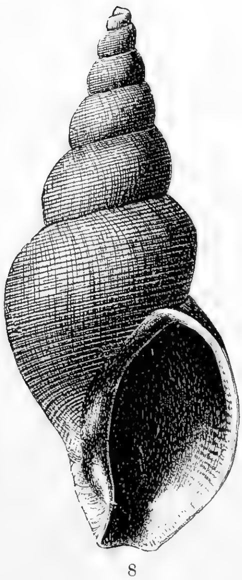
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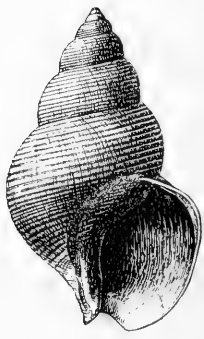
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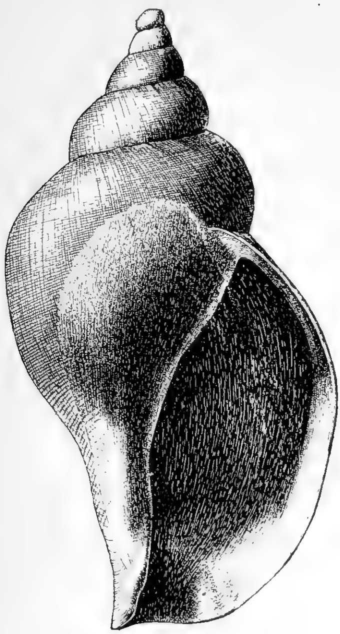
SHELLS FROM THE PACIFIC OCEAN.

For explanation of plate see page 732.



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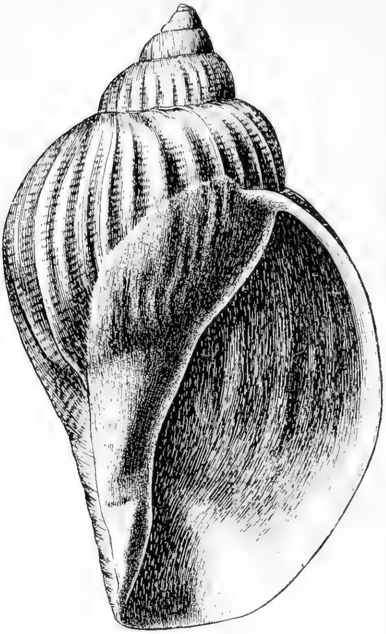

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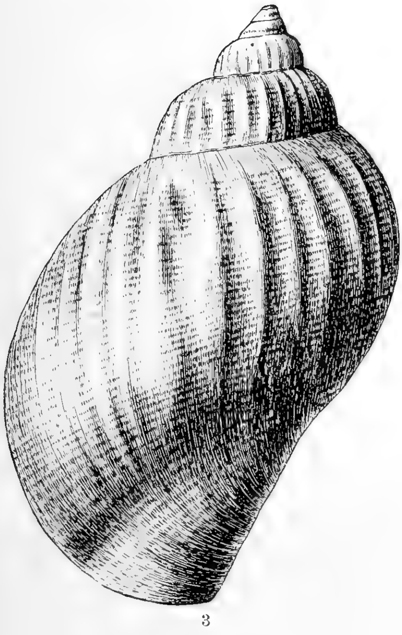

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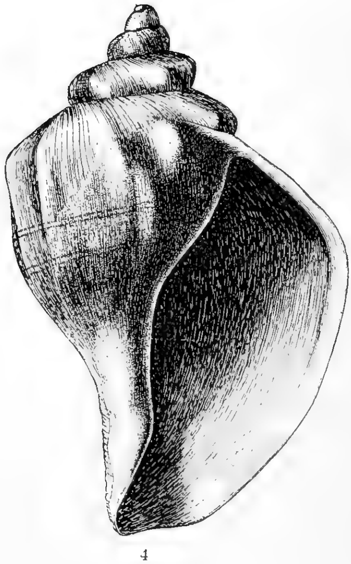
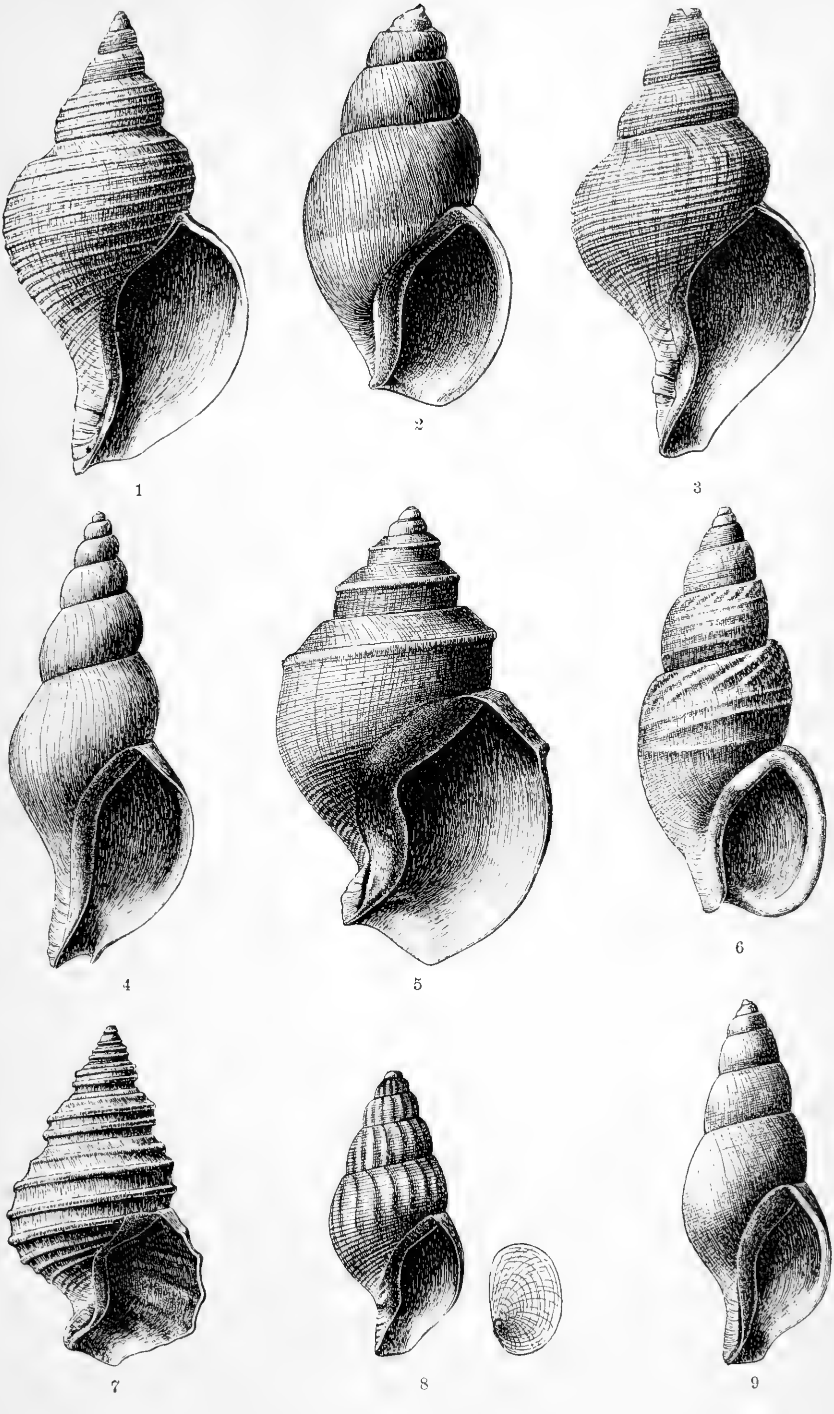


4

ALASKAN SPECIES OF STROMBELLA.

For explanation of plate see page 732.



ALASKAN SPECIES OF CHRYSODOMUS.

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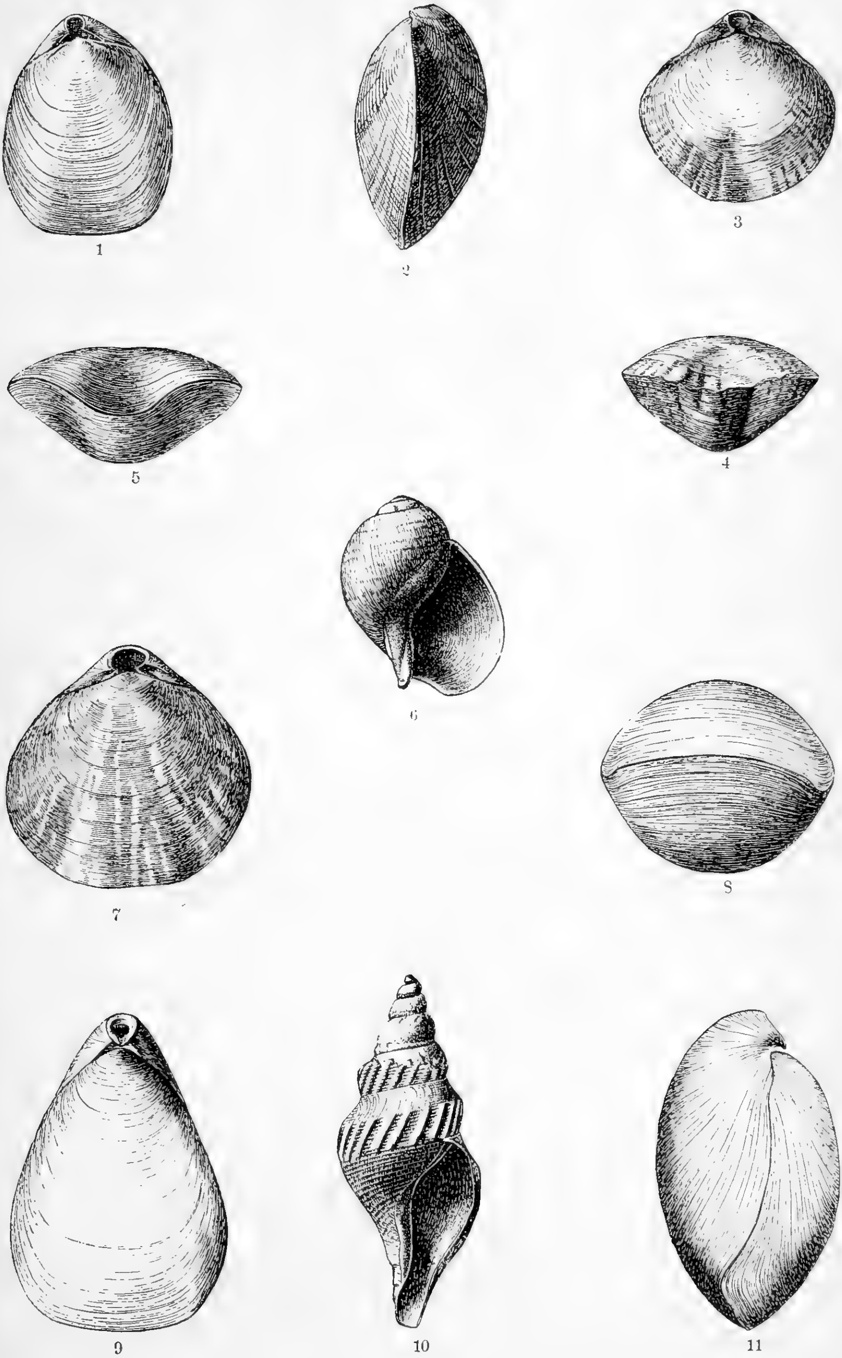
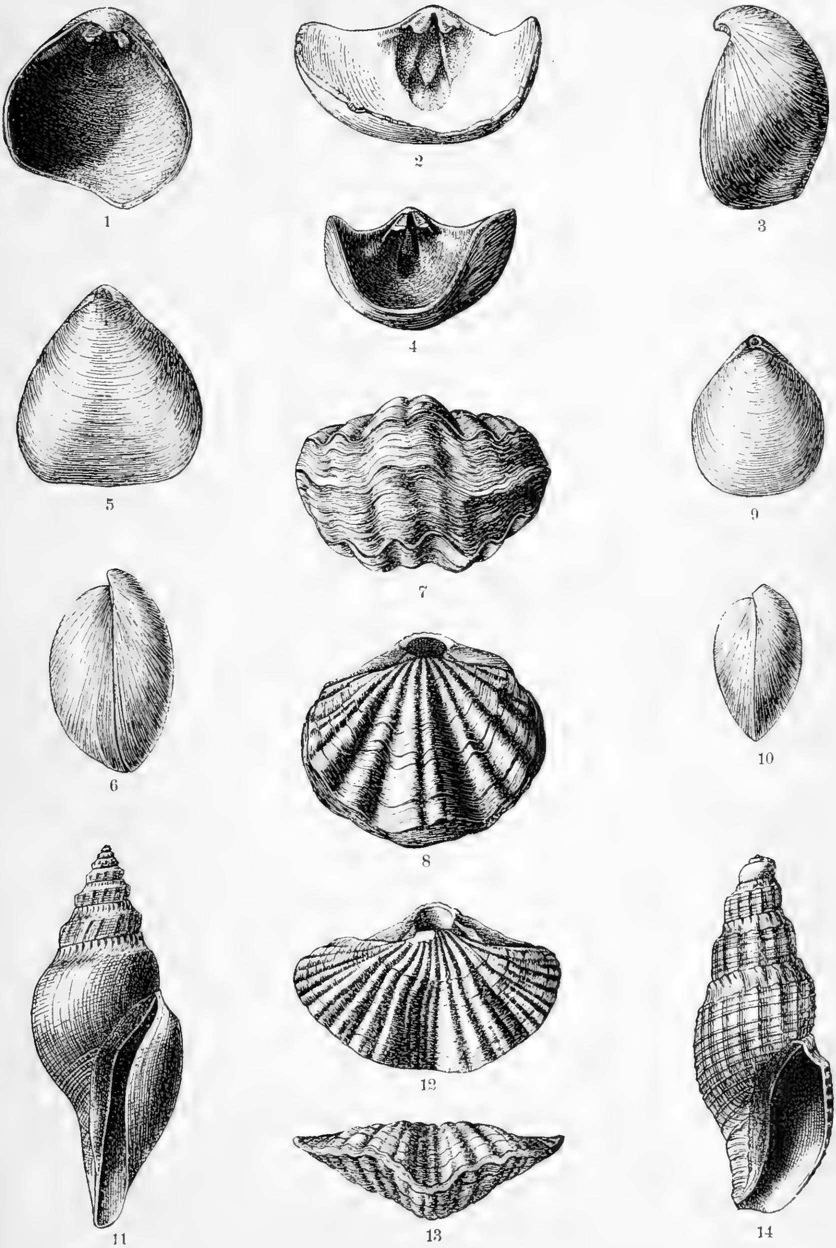


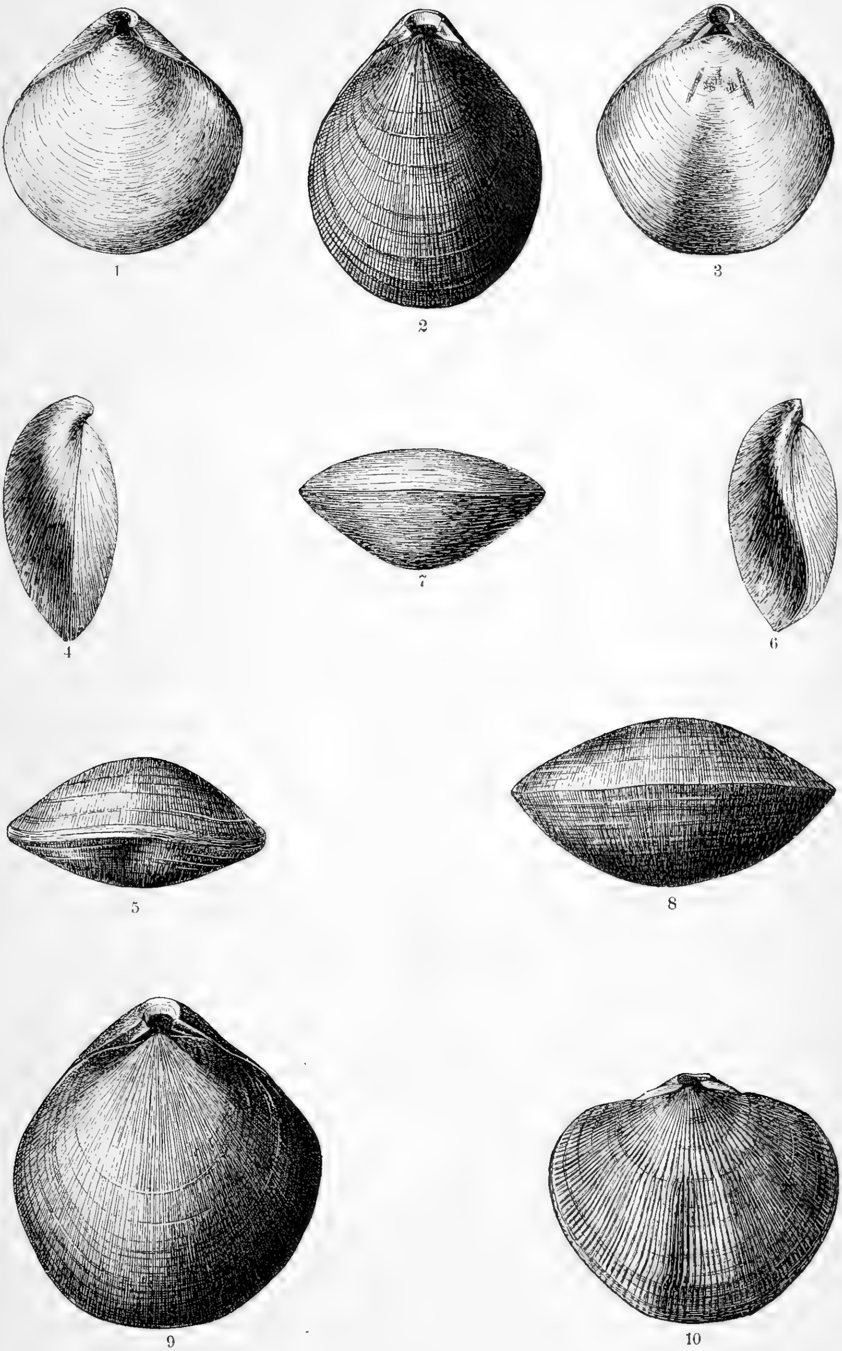
PACIFIC SHELLS AND BRACHIOPODS.

For explanation of plate see page 732.



PACIFIC SHELLS AND BRACHIOPODS.

For expianation of plate see page 732.



PACIFIC BRACHIOPODS.

For explanation of plate see page 733.

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